Abdominal Pain: A Rational Approach, Part 2

CAROLYN J. SACHS, MD, MPH and TIFFANY HSIEH, MD
University of California, Los Angeles

ABSTRACT: The approach to a patient with abdominal pain begins with a careful differential diagnosis. Keep in mind that the use of analgesia in patients with abdominal pain of unclear etiology does not hinder or delay diagnosis. Among other dangers, consider ovarian torsion in all female patients who present with severe localizing lower abdominal pain. Intussusception is the most frequent abdominal emergency in early childhood, especially in patients younger than 2 years. In pregnant women, appendicitis remains the most common general surgical emergency (about 1 in 1500 pregnancies); the diagnosis can be challenging, especially during the third trimester, because the gravid uterus can make the appendix difficult to visualize.

Key words: abdominal pain, ovarian torsion, intussusception, appendicitis

This two-part series on abdominal pain uses real-world cases (not “textbook” examples) to illustrate an approach that begins with a careful differential diagnosis. Some general guidelines for evaluating patients are listed in Box I. Here, in Part 2, we present cases of ovarian torsion, intussusception, and appendicitis during pregnancy. In Part 1 (CONSULTANT, October 2012, page 693), mesenteric ischemia, abdominal aortic aneurysm, and ectopic pregnancy were discussed.

CASE 1: YOUNG WOMAN WITH SEVERE ABDOMINAL PAIN

Initial evaluation. A 29-year-old woman presents to the emergency department (ED) with severe right lower quadrant (RLQ) pain of acute onset that began 3 and a half hours earlier. The patient woke from sleep and is accompanied by vomiting and chills. She denies fever, vaginal discharge, vaginal bleeding, and dysuria. One day earlier, she had similar but less intense pain for which she was evaluated at another ED and given trimethoprim-sulfamethoxazole for a presumptive urinary tract infection.

She was previously healthy and takes no long-term medications. She is sexually active with one male partner and has no history of sexually transmitted infections. Her last menstrual period occurred 6 days earlier.

The patient is crying because of the pain. Heart rate is 105 beats per minute; blood pressure, 120/81 mm Hg; respiration rate, 28 breaths per minute; temperature, 37°C (98.6°F); and oxygen saturation, 99% on room air. Head and neck, cardiac, pulmonary, skin, and extremity examination results are normal. The patient's abdomen is diffusely very tender, with rebound and guarding in the RLQ. Pelvic examination shows a closed cervical os, no cervical motion tenderness, bilateral adnexal

I – General Guidelines for Evaluating Patients With Abdominal Pain

• If dangerous causes of abdominal pain cannot be excluded from the differential diagnosis, either consult or admit. Do not send the patient home.

• Record vital signs and examine the patient after beginning each new treatment, during periods of observation, and before discharge.

• Very old and very young patients, as well as those with serious comorbidities, often do not exhibit the typical signs and symptoms of abdominal disorders such as appendicitis; a thorough workup and admission are usually warranted.

• Women of childbearing age must be treated as though pregnant until pregnancy is ruled out.

• All patients with abdominal pain need follow-up.

• Let patients know your concerns, and describe the symptoms that should prompt them to seek medical attention before the next scheduled visit.

Dr Sachs is a clinical professor of medicine at the emergency medicine center of the University of California, Los Angeles, Medical Center. At the time this article was written, Dr Hsieh was a PGY-4 resident at the same institution; she is now an associate physician with Kaiser Permanente at the Hayward/Fremont Medical Centers in California.
tenderness greater on the right side than on the left, and no abnormal masses. Rectal examination reveals heme-negative brown stool.

For this patient, the differential diagnosis includes:
- Appendicitis.
- Diverticulitis with perforation (possible, but less likely, in an otherwise healthy 29-year-old woman).
- Ectopic pregnancy (ruptured).
- Nephrolithiasis.
- Ovarian torsion.
- Ovarian cyst rupture.
- Tubo-ovarian abscess with rupture.
- Torsion of uterine fibroid.
- Endometriosis.

What tests would you order? Should the patient be given pain medication at this time (Box II)?

Further workup. Results of a urine pregnancy test are negative, and a urine dipstick test reveals no abnormalities. A bedside ultrasound examination by an ED physician shows no free fluid.

A surgical consultation is requested 30 minutes after the initial evaluation. The consultant asks that no opiates be given to the patient before her examination (see Box II). Fifteen minutes later the consultant arrives, and the patient receives fentanyl. The consultant recommends an abdominal series and a gynecologic consultation.

White blood cell (WBC) count is 15,200/µL, and hematocrit is 42.8%; all other laboratory results are normal. The abdominal series findings are normal, with no free air.

A formal pelvic ultrasound evaluation reveals an 8 × 7-cm cystic mass with multiple septations anterior to the uterus (Figure 1). The left ovary is normal; the right ovary is not visualized.

Outcome of this case. The consulting gynecologist recommends lapa-
rosocopy for presumptive tubo-ovarian abscess. At surgery a twisted 10 × 10-cm hemorrhagic right ovary and 4-cm right fallopian tube are found to be 2 full revolutions from their natural position.

**Ovarian torsion.** Rotation of the adnexa about its ligamentous supports with vascular compromise causes ischemia of the ovary that can lead to necrosis, hemorrhage, or peritonitis. Infertility can result if the condition is not treated promptly.

**Epidemiology.** Ovarian torsion has been described in all age groups, from fetal/neonatal to post-menopausal. About 15% of cases occur during infancy and childhood because of the relative mobility of the adnexa during that time. Women who are pregnant or undergoing ovarian hyperstimulation for infertility are at increased risk as a result of increased vascularity.1

**Etiology.** Torsion most often occurs in the presence of ovarian cysts (5 cm or larger) or neoplasms, which predispose the ovary to twist around its vascular pedicle. In up to 20% of cases, the ovaries are normal, a finding more commonly seen in children. Ovarian torsion is diagnosed more frequently on the right side, which may represent a workup bias due to suspicion for appendicitis. Isolated fallopian tube torsion can also occur.2

**Signs and symptoms.** A classic symptom of ovarian torsion is lower abdominal pain of sudden onset. In contrast to the clinical presentation of appendicitis, nausea and vomiting accompany the onset of pain. Consider the diagnosis in patients who report chronic pelvic pain with an intermittent time course or waxing and waning intensity.

Physical examination reveals marked adnexal tenderness but less cervical motion tenderness. A palpable adnexal mass is present in fewer than 50% of cases.1

**Diagnosis.** The diagnosis is primarily clinical; maintain a high index of suspicion in the appropriate scenario. Laboratory studies may not show any abnormalities and are nondiagnostic. A definitive diagnosis is made based on surgical findings.

Standard pelvic ultrasonography can reveal the presence of adnexal lesions and ovarian enlargement, but it lacks the sensitivity to reliably exclude the diagnosis of ovarian torsion.3 Color Doppler sonography can confirm blood flow to the ovary, which correlates with the ability to salvage fertility in 94% of cases.4 Absent or impaired ovarian venous flow had 100% sensitivity and 97% specificity for torsion in one prospective study that may have suffered from incorporation bias.5 The presence of arterial flow to a normal-appearing ovary on Doppler ultrasonography does not rule out torsion.6,7 A Korean study used Doppler to detect a “twisted vascular pedicle,” which was 87% sensitive in making the diagnosis of torsion preoperatively.7 This technique predicted ovarian necrosis in all patients who had a surgically confirmed diagnosis. Similar findings of a twisted pedicle with absent blood flow have been predictive of ovarian non-viability in more recent studies.

MRI and CT have limited utility. Cost, time, and radiation exposure are not justified for the majority of cases; however, these imaging studies may be useful when torsion is highly suspected, ultrasound findings are normal, and the gynecologist does not elect to operate or is not available for consultation.

**Treatment.** Treatment consists of emergency laparoscopy. Traditionally, the affected ovary was removed without detorsion because of the theoretical fear of embolism from a thrombosed ovarian vein and the inability to determine the viability of the ovary. The treatment paradigm has shifted toward operative evaluation and preservation of the ovary, even when it may appear necrotic. More recent studies confirm the safety of laparoscopic detorsion with preservation of fertility in a majority of patients who had blood flow on color Doppler sonography preoperatively.8,9

Oophoropexy is recommended in cases of torsion of normal ovaries in childhood; it is not routinely performed in cases of torsion resulting from an ovarian cyst. Unilateral, contralateral, and bilateral oophoropexy have all been performed to prevent recurrence of torsion, although there have been no randomized controlled trials to evaluate the efficacy of each procedure.

**LESSONS FROM THIS CASE**

- Consider the diagnosis of ovarian torsion in all female patients who present with severe localizing lower abdominal pain.
- The absence of ovarian blood flow on Doppler sonography is highly specific for torsion; however, a normal study does not rule out torsion.
- The use of analgesia in patients with abdominal pain of unclear etiology does not hinder or delay diagnosis.

**CASE 2: INFANT WITH EMESIS AND IRRITABILITY**

**Initial evaluation.** The parents of a 6-month-old infant bring him to the ED because he has been vomiting for the past 6 hours. They report that he has vomited all feedings since the morning. The vomitus is mostly food, nonbloody and nonbilious. He has not had a bowel movement today. He has also been irritable, with intermittent episodes of inconsolable crying every hour, which his parents say is very unusual for him. The parents deny any toxic ingestions. He has no history of constipation.

The birth history was unremarkable, with no complications. He has no significant medical history, receives no medications, and has no allergies. His immunizations are up to date. Heart rate is 132 beats per minute; blood pressure, 89/60 mm Hg; respiration rate, 21 breaths per minute; temperature, 37.3°C (99.1°F); and oxygen saturation, 95% on room air. The patient appears well and has moist mucous membranes. Results of pulmonary and cardiac examinations are normal. Abdomen is soft and nontender, with no palpable masses. Rectal examination reveals normal tone and no stool.

The differential diagnosis for this patient includes:

- Appendicitis.
- Child abuse.
- Corneal abrasion.
- Hair tourniquet.
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- Incarcerated hernia.
- Intussusception.
- Malrotation with volvulus.
- Meckel diverticulum.
- Sickle cell disease (splenic sequestration).
- Testicular torsion.

Ocular examination reveals no corneal abrasion with fluorescein staining. Results of the genital examination are normal; the testicles are descended bilaterally and are nontender. Skin is normal, with no rashes. Extremities are normal; no hair tourniquets are noted.

What tests would you order?

**Further workup.** Abdominal ultrasound shows intussusception, which is easily reduced with an air enema (Figure 2).

**Outcome of this case.** The patient is admitted and observed overnight with no complications or recurrence of the intussusception.

**Intussusception.** In patients with intussusception, one segment of intestine with its mesentery telescopes into a more distal segment. The most common site is at the ileocecal junction (termed ileocolic intussusception). The blood supply in the mesentery is compromised, leading to venous and lymphatic congestion, intestinal edema and, ultimately, ischemia with perforation and peritonitis.

**Epidemiology.** The incidence peaks from ages 3 months to 5 years. Intussusception is the most common abdominal emergency in early childhood, especially in patients younger than 2 years. It is associated with a variety of conditions, including Meckel diverticulum, cystic fibrosis, and Henoch-Schonlein purpura.

**Etiology.** The majority of cases in young children (greater than 75%) are idiopathic, although a growing number of studies implicate viral infection, especially adenovirus. Older children usually have a pathologic lead point (portion of intestine that is dragged into a distal segment) from a Meckel diverticulum, polyp, tumor, or vascular malformation. Intussusception is almost always pathologic when it occurs in adults.

There was an association with a previously used rotavirus vaccine (Rotashield) based on passive reporting to the Vaccine Adverse Events Reporting System. Risk was increased within 3

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Figure 2 – Transverse ultrasound view of the right upper quadrant in this patient with intussusception demonstrates a target-like mass with multiple concentric rings, representing the proximal portion of intestine that has telescoped into a more distal portion.
weeks of vaccination. A CDC multistate investigation concluded that RotaShield increased the risk of intussusception by 1 or 2 cases among each 10,000 infants vaccinated. Based on the results of this investigation, RotaShield vaccine was withdrawn from the market in 1999.

The FDA licensed RotaTeq and Rotarix vaccines in 2006 and 2008, respectively. Large multinational pre-licensure trials found no increased risk of intussusception. Smaller studies outside the United States detected a low-level increased risk, especially within the first 30 days post-immunization; however, this level was still substantially lower than with the RotaShield vaccine.

Signs and symptoms. Intermittent, crampy abdominal pain, accompanied by inconsolable crying and drawing of the legs up toward the body, should raise suspicion for intussusception. Initially, emesis is nonbiliious, but it may become bilious once intestinal obstruction progresses. An episode of pain should be observed in the ED.

The following classic triad is found in fewer than 15% of cases:

- Colicky abdominal pain (50% to 90% of cases).
- "Sausage-shaped" mass palpable on the right side of the abdomen.
- Heme-positive stool ("currant jelly" stool, a mixture of blood and mucus, is very rare).

Intussusception can present with lethargy or altered mental status, mimicking sepsis or meningococcal sepsis.

Diagnostic studies. Laboratory studies are not useful in making the diagnosis but can rule out metabolic causes.

Patients with a typical or classic presentation can directly undergo non-operative reduction using air, water-soluble contrast, or barium under sonographic or fluoroscopic guidance. An abdominal series is not recommended to rule out intussusception, although it is often ordered in the evaluation of nonspecific abdominal pain in children. In one study, more than 20% of children with intussusception had negative plain films. Positive findings may include:

- Absence of colonic gas.
- "Target sign": two concentric radiolucent circles superimposed on the right kidney, corresponding to peritoneal fat within the intussusception.
- "Crescent sign": a soft tissue density projecting into the large bowel, representing the intussusception.

Ultrasonography is the method of choice to detect intussusception at many institutions. It is most sensitive (98% to 100%) in expert hands, but the results are operator dependent. The classic finding is a "bull's eye" or "coiled spring" lesion, which represents intestine within intestine. Ultrasonography can identify rare ileoileal intussusception and a pathologic lead point if one is present. Doppler ultrasonography may differentiate cases that cannot be reduced with enema (ie, those cases in which a lack of perfusion indicates bowel ischemia).

CT should be reserved for patients in whom the diagnosis is unclear or to characterize pathologic lead points.

Treatment. Initially, patients should receive hydration and pain medication. For the stable patient with high clinical suspicion or radiographic evidence of intussusception and no evidence of bowel perforation, non-operative reduction under sonographic or fluoroscopic guidance is recommended, with comparable success rates of 80% to 95%. Ultrasound-guided reduction obviates the need for a radiation dose.

Air or saline enema has consistently proved to be safer and deliver less radiation to the patient than barium, which was the contrast medium traditionally used.

Barium is noxious if it spills into the peritoneum through an undiagnosed perforation. The risk of perforation with enema administration is about 1%.

Following non-operative reduction, the recurrence rate is about 10%; it is most likely to occur during the first 24 hours after the procedure. Because of the risk of recurrence, we recommend a short (12- to 24-hour) admission for observation after successful reduction.

Surgery is indicated for patients with peritonitis, perforation, shock, or unsuccessful reduction with an enema. Antibiotics should be administered before surgery to cover colorectal organisms.

Lessons from this case

- Abdominal examination and stool findings are often normal in patients with intussusception.
- The history is the most important factor in making the diagnosis.
- In cases of low suspicion, observe the patient in the ED for an episode of pain before deciding to discharge with good return precautions.

Case 3:

Pregnant woman with abdominal pain and nausea

Initial evaluation. A 34-year-old woman who is 20 weeks’ pregnant (gravida 3, para 2) presents with periumbilical pain that began about 12 hours earlier. The pain has intensified throughout the day, with localization to the right lower abdominal region. She had no episodes of similar pain during her previous normal pregnancies. She reports associated nausea and subjective fever but no vomiting. She denies any constipation, dysuria, increased frequency, diarrhea, or vaginal symptoms, including bleeding and discharge. She has no allergies and no significant medical or surgical history. Medications include prenatal vitamins and an iron supplement for anemia.

Temperature is 37.3°C (99.1°F); heart rate, 104 beats per minute; blood pressure, 118/62 mm Hg; respiration rate, 16 breaths per minute; and oxygen saturation, 98% on room air. Head, eyes, ears, nose, and throat are normal; neck is supple; lungs are clear; and heart rate is regular. Abdominal examination is notable for a gravid uterus with a fundal height of 21 cm, RLQ tenderness with mild palpation, positive rebound, and voluntary guarding. A positive psoas sign is noted. Pelvic examination results are normal.

The differential diagnosis for this patient includes:

- Appendicitis.
- Round ligament pain.
- Preeclampsia and HELLP (hemolysis, elevated liver enzyme, low platelets) syndrome (usually involving the right upper
quadrant and occurring in the third trimester).
• Premature labor.
• Mesenteric adenitis.
• Diverticulitis.
• Urinary tract infection or pyelonephritis.
• Ovarian cyst rupture.
• Ovarian abscess or torsion.

What diagnostic tests would you order?

Further workup. Laboratory studies disclose the following values: WBC count, 13,700/µL; hemoglobin, 12 g/dL; hematocrit, 34%; liver function tests, normal; and urinalysis, 10 red blood cells per high-power field (hpf) and 12 WBCs per hpf.

Abdominal ultrasonography shows a fetus with a gestational age of 20 weeks (6 days consistent with the last menstrual period) and good fetal heart tones; it also reveals equivocal findings for acute appendicitis.

Outcome of this case. A surgical consultation is obtained, and an emergency appendectomy is recommended on the basis of the clinical history and physical examination. An obstetrician is also consulted and agrees with the plan. The patient undergoes an open laparotomy under general anesthesia with removal of an acute inflamed, non-perforated appendix. She has an uncomplicated post-operative course and delivers a healthy infant at term.

Appendicitis in pregnancy. The lifetime prevalence of appendicitis in the general population is 7%. It is the most common general surgical problem in pregnancy, with an incidence of 0.06% to 0.1% (about 1 in 1500 pregnancies). There is a slightly higher rate of appendicitis during the second trimester.

Etiology. Obstruction of the appendiceal lumen with fecal matter results in distention and edema. Ischemic necrosis of the appendix occurs, with resultant infection of devitalized tissue with bacteria.

Signs and symptoms. The sensitivity and specificity of various signs and symptoms associated with appendicitis in non-pregnant patients have been studied (these are listed in the Table), but no single finding or combination of findings is sensitive or specific enough to be useful in making a definitive diagnosis. RLQ pain is the most common symptom in appendicitis. Because of the enlargement of the uterus, the location of the appendix migrates a few centimeters superiorly during pregnancy; however, several studies have demonstrated that RLQ pain occurs near McBurney’s point in most pregnant patients, regardless of trimester. Nausea and vomiting usually follow the onset of pain.

Signs that suggest acute appendicitis include the following:
• Psoas sign: RLQ pain elicited with passive extension of the right hip (patient lying on the left side with knee in flexion) or by active flexion of the right hip while supine, resulting from inflammation of the peritoneum overlying the iliopectineus muscle.
• Obturator sign: pain and spasm of the obturator internus muscle with hip flexion and internal rotation, caused by contact of the inflamed appendix with the muscle.
• Rovsing sign: RLQ pain elicited with deep palpation starting from the left iliac fossa and moving upward, which increases pressure around the appendix.

Pregnant patients may not display prominent peritoneal signs, since the gravid uterus lifts the anterior abdominal wall away from the inflamed appendix.

Laboratory studies. Pregnancy is associated with physiologic changes including leukocytosis, which can confound the diagnosis of acute appendicitis. The normal WBC count during pregnancy ranges from 6000/µL to 16,000/µL, and can rise to 20,000/µL to 30,000 during labor. One retrospective review found that gravid patients with confirmed appendicitis had a WBC count of 16,400/µL compared to 14,000/µL in patients with a normal appendix. Although leukocytosis can be a normal finding in pregnancy and is thus not useful diagnostically, surgical consultants will often request the test.

Because the appendix lies close to the bladder and ureter, urinalysis reveals microscopic pyuria or hematuria in up to a third of patients with appendicitis.

Imaging studies. Imaging is recommended for all patients in whom the diagnosis is uncertain.

Ultrasonography is the initial diagnostic study of choice in pregnant pa-

### Table – Sensitivity and specificity values for signs and symptoms of acute appendicitis in non-pregnant patients

<table>
<thead>
<tr>
<th>Sign or symptom</th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
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</thead>
<tbody>
<tr>
<td>Right lower quadrant pain</td>
<td>81</td>
<td>53</td>
</tr>
<tr>
<td>Rigidity</td>
<td>27</td>
<td>83</td>
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<tr>
<td>Migration of pain</td>
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<td>82</td>
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<tr>
<td>Psoas sign</td>
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<td>95</td>
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<tr>
<td>Fever</td>
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<td>79</td>
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<tr>
<td>Rebound tenderness</td>
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<td>69</td>
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<tr>
<td>Guarding</td>
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<td>57</td>
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<tr>
<td>No history of similar pain</td>
<td>81</td>
<td>41</td>
</tr>
<tr>
<td>Rectal tenderness</td>
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<td>77</td>
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<tr>
<td>Vomiting</td>
<td>51</td>
<td>45</td>
</tr>
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</table>

Adapted from Wagner JM et al. JAMA. 1996.
tients; however, operator dependence limits its utility in many centers. Its accuracy in practice is probably much lower than that described in the literature. It can also be used to evaluate the fetus, uterus, placenta, and ovaries. The diagnosis of appendicitis is made if a non-compressible blind tubular structure with a maximum diameter of greater than 6 mm is visible in the RLQ. A gravid uterus can make the appendix difficult to visualize, especially in the third trimester.24

MRI is a second-line option if clinical suspicion is high and ultrasound findings are non-diagnostic; however, it is expensive and time-consuming.25 An advantage of MRI is that the patient avoids exposure to ionizing radiation. One meta-analysis of six studies showed a pooled sensitivity of 91% and specificity of 98% for MRI.26 Keep in mind that gadolinium use is contraindicated during pregnancy.27

Do not delay surgical evaluation to obtain an MRI scan because this increases the risk of perforation.

CT is readily available but exposes both the patient and the fetus to ionizing radiation. It is recommended only with caution in patients who have inconclusive clinical examination and ultrasound findings if MRI is unavailable. CT is useful in detecting other abdominal pathology, and it has proven diagnostic value in non-pregnant patients with suspected appendicitis. Positive findings include RLQ inflammation with an enlarged appendix or an appendicolith. Before the scan is performed, discuss with the radiologist whether modifications to the CT protocol can minimize fetal radiation exposure. The dose with a single pelvic CT scan is under the threshold for teratogenesis and is preferable to delaying surgery and permitting an inflamed appendix to perforate. Some worry that fetal radiation from CT may confer an increased risk of carcinogenesis, extrapolating risk based on data from survivors of the atomic bomb. Limited data are available for this population: one meta-analysis of three retrospective studies in pregnant women reported that CT had a sensitivity of 85.7% and a specificity of 97.4%.23

Treatment. Treatment consists of surgical appendectomy. Limited data are available on the safety and efficacy of a laparoscopic approach in pregnant women.

Perforation increases the risk of fetal loss and early delivery; thus, a higher negative appendectomy rate is acceptable. Very ill patients with appendiceal rupture require emergent laparotomy for irrigation of the peritoneal cavity. There is limited evidence for the management of contained perforation in stable pregnant patients. Current recommendations include intravenous antibiotics and admission for close observation.

LESSONS FROM THIS CASE
• Right lower quadrant pain in appendicitis occurs close to McBurney’s point in pregnant women despite the enlargement of the uterus.
• Ultrasonography and MRI are the imaging studies of choice for diagnosing appendicitis in pregnant women. Avoid CT if possible because of potential risks associated with ionizing radiation exposure; however, if ultrasound findings are nondiagnostic and MRI is not readily available, CT may be preferred over a negative laparotomy or risk of perforation with observation.
• The diagnosis of acute appendicitis can be very difficult, especially in late pregnancy. Obtain surgical and obstetric consultations expeditiously in a pregnant patient in whom you suspect appendicitis.

REFERENCES: