30 Acute abdomen in pregnancy

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One of the most anxiety-provoking patients to deal with is the pregnant patient with acute abdominal pain. It is widely quoted that 1/500–635 pregnancies will be complicated by an acute abdomen requiring surgery. With two patients to think about, mother and child, and the complications that can go along with a delayed or missed diagnosis, it is no wonder it leads to anxiety for all involved. To deal with the complexities that go along with diagnosing an acute abdomen in a pregnant patient, one needs to understand not only the differential diagnosis but also the physiologic changes of pregnancy that will affect the evaluation and diagnosis.

PHYSIOLOGIC CHANGES OF PREGNANCY

Physical findings in the pregnant patient with an acute abdomen are different from that of the nonpregnant one. Much of the decreased prominence of abdominal signs is due to the expanding uterus. In the patient who is not pregnant, the average weight of the uterus is 70g. Over 40 weeks of pregnancy, it can expand to 1110g and can have an intrauterine volume of 5liters (1–3). As this enlargement occurs, the intestine and omentum are pushed into the upper abdomen. The omentum is less able to be the watchman of the abdomen and wall off areas of peritonitis due to encroachment of the uterus. The ovaries will come to lie posterior to the uterus (1). This makes assessment of ovarian pathology more difficult especially by transabdominal ultrasound. With the enlargement of the uterus also comes stretching of the abdominal wall. As the abdominal wall stretches, it shows fewer signs of direct peritoneal irritation. Classic signs, such as rebound and guarding, are less prominent.

Previously a paper by Baer et al. in 1932 reported that with the enlargement of the uterus, the appendix moves upward and laterally from its usual position at McBurney's point so that by late pregnancy it is actually closer to the gallbladder. He showed this by performing barium enemas to show the position of the appendix and cecum (4). In 2003, a paper by Hodjati and Kazerooni in the International Journal of Gynecology and Obstetrics reevaluated the anatomical location of the appendix with pregnancy. In their prospective study, three groups of women were compared. The first was 165 women in their 37th to 40th week of pregnancy who were undergoing elective c-sections. The second group was 26 women between 19 and 39 weeks of pregnancy with acute appendicitis. The final group was 100 nonpregnant females with acute appendicitis. Each was evaluated for appendix location and normal was noted to be within 2cm of McBurney's point. In their study, 15% of the first group had an abnormal position, 23% of the second group, and 17% of the third. The study showed no significant difference between the normal control and those who were pregnant (5).

Other physiologic changes may be attributed to hormonal changes associated with pregnancy such as the elevation in estrogen and progesterone levels. Several studies have shown that as levels of these hormones increase throughout pregnancy, orocecal motility slows. A study by Wald et al. showed that the gastrointestinal motility slowed by one-third during the third trimester of pregnancy compared with postpartum rates (6,7). It has also been shown that levels of the hormone motilin decrease. This affects the migrating motor complex also leading to slowed orocecal motility (8). The slowed transit can compound problems with constipation or other underlying abdominal pathology making diagnosis again more difficult. Progesterone has also been linked to decreased lower esophageal sphincter pressure and affects the urologic system. Dilation and slowing of peristalsis of the ureters have been associated with increase in progesterone. This may lead to urinary tract infection from urinary stasis (9,10).

There are normal changes that take place in pregnancy, which change the results of laboratory tests. This can make looking for bleeding or infection more difficult. Laboratory test results expected in pregnancy are shown in Table 1. For a few tests, the lab results can still have significant diagnostic value especially in the case of pyelonephritis, hepatitis, or pancreatitis.

IMAGING AND THE PREGNANT PATIENT

With the fetal effects of radiation to consider, it is important to understand what imaging modalities are available and safe. While there may be anxiety in using some radiologic modalities, it is important to remember that the greatest danger to both fetus and mother may be delay in diagnosis.

Ultrasound

Ultrasound may be used as both a diagnostic and a therapeutic modality. It is the imaging modality of choice due to its ease of use, low cost, and safety. It may be used to evaluate mother and fetus at the same time providing evaluation of amniotic fluid and size of the fetus while possibly diagnosing relevant pathology in the mother.

Magnetic Resonance Imaging

Magnetic resonance imaging (MRI) is a safe modality to use providing diagnostic information on the mother with little risk to the fetus at any stage of pregnancy. MRI is beneficial compared with computed tomography (CT) in that it is capable of giving large field-of-view images in any plane with excellent soft-tissue contrast (11). There is no exposure of the mother or the fetus to any ionizing radiation. Often no contrast is needed to establish a diagnosis. Gadolinium, a contrast agent used in MRIs, does cross the placenta and its

Table 1 Changes in Laboratory Test Results Expected in Pregnancy

Test	Result
Hemoglobin	Decreased
Hematocrit	Decreased
White blood cell count	Increased
Differential white blood cell count	Increased neutrophils
Platelet count	Unchanged
Electrolytes (serum)	Decreased CO ₂
Glucose (fasting)	Decreased
Creatinine (serum)	Decreased
Amylase	Slightly increased
Aspartate aminotransferase	Unchanged
Alanine aminotransferase	Unchanged
Alkaline phosphatase	Increased
g-Glutamyl transpeptidase	Unchanged
Urinalysis	Unchanged
Arterial blood gas	Decreased pCO ₂ ; slightly increased pH

effects on the fetus are not well understood. However, there is general consensus that it should not be used in the pregnant patient unless there is high likelihood that benefits of its use outweigh the risk to the fetus. In the acute abdominal setting, MRI is beneficial for evaluation of the biliary tree for stones with sensitivity greater than 90% (11). It may be used to diagnose acute appendicitis, bowel obstruction, and areas of abscess formation, inflammation, and hemorrhage.

CT

CT use is often feared due to the risk of ionizing radiation to the fetus. Guidelines for surgical problems during pregnancy from the Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) state that expeditious and accurate diagnosis should take precedence over concerns for ionizing radiation. Radiation dosage should be limited to 5 to 10 rads in the first 25 weeks of pregnancy (12). Modern CT scanners deliver doses of radiation below this as a single test. A CT of the abdomen–pelvis delivers about 2 to 4 rads (13–16). However, cumulative radiation exposure must be considered: other tests that have been done may affect the decision to use CT. Consider also that IV contrast should not be used and try to minimize cuts of the CT.

Nuclear Medicine

Fetal exposure with nuclear medicine studies is quoted to be less than 0.5 rads. This again is below the limit of 5 to 10 rads quoted. In light of this, the radionuclotides may be administered including technetium-99 (13,17).

Once workup is completed, decision for treatment will depend on the specific diagnosis. However, there are some tenants for surgery that hold true for all patients. Indications for emergency laparotomy are no different in the pregnant patient than that in a nonpregnant patient. If possible, elective procedures should wait until after the pregnancy is completed unless that is a compelling reason that it benefits the patient or the pregnancy. Elective procedures include cholecystectomy for uncomplicated gallstone disease and inguinal hernia repair for asymptomatic hernia. The second trimester of pregnancy is the best time for performance of any elective or semi-elective

procedure. The decision to perform a c-section delivery should be made outside of the decision for an exploratory laparotomy. Successful vaginal deliveries can be performed postoperatively.

Perioperative Considerations

Perioperative consideration should be given to fetal heart monitoring. It is difficult to keep fetal heart monitors on sterily during an abdominal surgery and monitoring may create a significant distraction. There are no definitive studies demonstrating that intraoperative fetal monitoring makes a difference in fetal outcome. The value of intraoperative fetal monitoring must be determined on a case by case basis. Pre- and postoperative fetal and contraction monitoring are recommended at a viable gestational age.

Preterm labor is also a concern with this population. The use of tocolytics is somewhat controversial and no consensus exists. The SAGES guidelines recommend no prophylactic use of tocolytics (13). Their use is also not recommended in the presence of maternal infection (9). Tocolytic benefits must be weighed against risks and obstetric consultation is warranted.

Laparoscopy and Pregnancy

At one time, it was felt that laparoscopy could only be used safely in the first and second trimesters of pregnancy. However, there are several published reports of use of laparoscopy in the third trimester without detriment to the patient or fetus. The SAGES guidelines now state that laparoscopy may be performed in any trimester and indications are the same in the pregnant and nonpregnant patients (13).

ACUTE APPENDICITIS

Appendicitis is the most common indication for nonobstetric surgery and occurs in 1/766 to 1/3000 pregnancies (18,19). There is no increased risk of appendicitis associated with pregnancy, but there is credible concern that the severity is increased in the pregnant patient. This may be due to the difficulty and delay of diagnosis during pregnancy. There are many common symptoms of pregnancy that may mimic appendicitis, such as nausea, vomiting, and round ligament pain. The leukocytosis of pregnancy may also obscure evaluation. It has also been previously reported that the anatomic location of the appendix changes with the growing uterus. More recent studies as noted previously in this chapter have refuted this idea and overall the appendix remains in its normal position. The diagnosis of appendicitis preoperatively in the pregnant patient has been reported in only one-half to three-fourth of the cases taken to the operating room (OR) (18,20,21). Finally due to the difficulty in diagnosis and the subjective reluctance of some to take a pregnant patient to the OR, the incidence of perforation is about 25% to 40% (18,21,22). This is even more concerning in light of the risk of fetal demise, which is 7% to 10% in the nonperforated appendicitis case and up to 24% if the appendix is perforated (18,22–24).

Signs

Direct abdominal tenderness is the most constant physical finding among pregnant patients with appendicitis. Only rarely is this finding absent (25,26). In the first trimester, tenderness is usually well localized in the right lower quadrant. With advancing gestation, there is still some thought that

tenderness may be found in the right periumbilical area or right upper quadrant; however, in the study by Hodjati et al., this was not necessarily true. About 55% to 75% of patients have demonstrable rebound tenderness (21,25–28). One-half to two-thirds of patients have abdominal muscle rigidity (21,25–29). Rovsing's sign is present approximately equally in pregnant as in nonpregnant patients with appendicitis. Psoas irritation is less frequently observed in pregnancy (30). Rectal examination is often overlooked in the pregnant patient with appendicitis, but one group has found that tenderness is usually present, especially in the first trimester (25). Fever and tachycardia are variably present and are not sensitive signs for appendicitis in pregnancy.

Diagnostic Aids

The physiologic leukocytosis (as high as 15,000/mm³) during pregnancy and the wide range of normal values limit the usefulness of the leukocyte count for the diagnosis of appendicitis (21). Severe disease may be present when the leukocyte count is normal (20). Greater than 80% polymorphonuclear leukocytes are often present when appendicitis complicates pregnancy (21,25). Again, however, the test is not sufficiently sensitive to rule out disease and it discriminates poorly between those patients with and those without appendicitis. Ten to twenty percent of pregnant patients with appendicitis have an abnormal urinalysis, usually showing pyuria alone (25,27). Bacteriuria indicates a urinary tract infection. Asymptomatic bacteriuria is common enough in pregnancy that it may well occur coincidentally with appendicitis (31). Ultrasound may be the initial radiologic evaluation tool for diagnosis of appendicitis. However, it may be variable in its results due to operator performance, the gravid uterus, or a retrocecal appendix. MRI and CT are gaining popularity as evaluation tools. A recent systematic review from 2009 showed good sensitivity and specificity of both when ultrasound was normal or inconclusive (18).

Treatment for appendicitis is either open or laparoscopic appendectomy. Choice should be made depending on the skill and comfort level of the surgeon and clinical picture. No longer is laparoscopy limited to the first and second trimesters of the pregnancy. Reports now show the safety of laparoscopy in the third trimester as well (32). Advantages reported for laparoscopy over the open approach include better intra-abdominal visualization, less uterine manipulation, less postoperative pain, early return of GI function, and earlier ambulation postoperatively (32,33).

Technique for laparoscopic entrance into the abdomen is variable. Veress needle, and open Hassan-type techniques are both reported and are safe in those experienced in the techniques (32). Veress needle insertion usually is done in the midclavicular line about 2 cm below the costal margin. Once performed, the port may be placed blindly or better yet with an optical trocar. Open surgery should be performed over the point of maximum tenderness or at McBurney's point.

CHOLELITHIASIS

Although laparoscopic cholecystectomy is reported to be the most common laparoscopic procedure in pregnancy, pregnancy itself does not increase the risk of acute cholecystitis. It is reported to occur in about 1 in 1600 to 10,000

pregnancies (34–36). During pregnancy, the formation of gallstone and gallbladder sludge is common, but most women remain asymptomatic.

Signs and Symptoms

As in the nonpregnant patient, the most reliable symptom is right upper quadrant pain. Previous studies have shown that about 28% present with pain (9,37).

About half of the patients have vomiting and a minority are febrile (38). Patients will often give a history of previous similar episodes. Right upper quadrant direct tenderness is usually present, but in the absence of complications, rebound tenderness is rare. The pain may radiate to the back. In the occasional patient, there is a palpable gallbladder.

Cholecystitis may be confused with appendicitis, particularly in the third trimester. Landers and colleagues (38) reported a woman at 30 weeks of gestation who underwent laparotomy to rule out appendicitis. The appendix was normal, but she developed *Salmonella* sepsis postoperatively. The gallbladder was found to be the source of the organism when she subsequently returned to the OR for cholecystectomy.

Diagnostic Aids

Gallstones are present in more than 95% of patients with cholecystitis. Ultrasonography has been found to be extremely accurate in the diagnosis of cholelithiasis. With cholecystitis, it may show not only gallstones but also gallbladder wall thickening and pericholecystic fluid. Ultrasound can also show common bile duct dilation. Since this modality does not require ionizing radiation, it is preferred in pregnancy. If additional diagnostic information is needed for clinical management, the radiation dose of a radionuclide scan of the gallbladder is not prohibitive.

Blood tests are of limited diagnostic value for the patient suspected to have cholecystitis. Leukocytosis may be present, but it is neither a sensitive nor a specific marker. Serum alkaline phosphatase is normally elevated in pregnancy. A high value should not be taken as evidence of cholestasis. Other hepatic enzymes, such as aspartate transferase and alanine transferase, may be helpful in distinguishing cholecystitis from hepatitis. Transient elevation of the serum amylase level may be seen in up to one-third of patients (39,40). A markedly elevated serum amylase level suggests pancreatitis, which may complicate the course of gallbladder disease. Occasionally, a patient may be jaundiced with an elevated bilirubin level. If the patient has had persistent vomiting, evaluation of electrolyte status is essential.

Treatment

Treatment of symptomatic cholelithiasis, otherwise known as biliary colic, can be controversial. Many people recommend nonoperative treatment for biliary colic. However, as shown in their review of the disease, Steinbrook et al. reported recurrence of symptomatic gallstones in 92% of women managed nonoperatively in their first trimester, 64% in their second, and 44% in their third (13,41). A 57% symptom recurrence during pregnancy and a 23% complication rate of acute cholecystitis and gallstone pancreatitis are reported (13,42).

Many favor initial treatment for the pregnant patient with uncomplicated acute cholecystitis to be supportive. Intravenous fluids should be given to prevent dehydration and the patient is made nothing-by-mouth. Nasogastric suction is appropriate if there has been significant vomiting. Analgesia may be given as needed. Meperidine is preferred to morphine, as the latter may produce spasm of the sphincter of Oddi. All narcotics may affect the sphincter of Oddi, but it appears to be more so with morphine. *Since* early cholecystitis is a sterile process, antibiotics are often unnecessary. If symptoms are persistent, or if systemic or local signs are prominent, broad-spectrum antibiotic coverage is warranted (43). Patients who fail to respond to conservative measures, or who have recurrent bouts of illness, are candidates for surgery. Selected patients may be considered for a percutaneous drainage procedure, that is, cholecystostomy tube, in order to defer definitive therapy (44).

The patient who responds promptly to supportive therapy may be observed, with the hope of avoiding an operation during pregnancy, or may be scheduled for an elective cholecystectomy. A prospective comparison of these treatment strategies is unavailable. Many authors favor the former approach, but the latter has proponents (45,46). Medical therapy is associated with a high risk of relapse, often requiring hospitalization prior to delivery (46). If there is choice about the timing of cholecystectomy, the second trimester seems to be the interval when fetal complications are minimized.

Though once considered contraindicated, there is a growing body of literature supporting the safety of laparoscopic cholecystectomy during pregnancy (47,48). SAGES guidelines list laparoscopic cholecystectomy as the procedure of choice in the pregnant patient with gallbladder disease regardless of trimester (13). The procedure is usually performed in the second trimester, but many cases have been reported in the first and third trimesters. Guidelines published by SAGES note that intraoperative cholangiography exposes both the mother and the fetus minimally and may be used selectively intraoperatively during cholecystectomy (13). Pelvic shielding is recommended. Endoscopic retrograde cholangiopancreatography with papillotomy and stone extraction may also be performed during pregnancy (49–51). This may be done pre-, post-, or intraoperatively (13). Candidates for this procedure would be those with known or suspected calculous obstruction of the biliary duct. Fetal irradiation can be minimized by uterine shielding and limitation of fluoroscopy time.

Course

Acute cholecystitis may be complicated by empyema, perforation, pancreatitis, or failure to respond to medical management. As stated previously, management is supportive unless the patient has pancreatitis, cholangitis, or common bile duct obstruction (9). Among patients managed conservatively during pregnancy, 62% to 84% may be carried through to delivery without operation (38,39,40). In the series reported by Landers and coworkers (38), medical therapy was deemed to have failed if symptoms persisted beyond the 4th day in the hospital, or if there were more than three recurrences in the same trimester. Pleading against excessive conservatism, Dixon and colleagues (45) cited two cases in which patients required total parenteral nutrition for 27 and 30 days,

respectively. One of these patients developed pancreatitis. Of 26 patients in their series, 15 had recurrent episodes of biliary colic during pregnancy (45). Data from published series are often incomplete, but perinatal outcome appears to be favorable if disease is uncomplicated or if surgical treatment is effected in the second trimester (31,39,40,45,52).

PANCREATITIS

Occurrence

Pancreatitis is an unusual, but potentially devastating, complication of pregnancy that may present with acute abdominal pain. In more recent series, case:delivery ratios range from 1:1289 to 1:3333 (53–56). Pregnancy may predispose women to the development of pancreatitis, but this notion is poorly substantiated and controversial (53,54,57,58). Recognized risk factors for pancreatitis include cholelithiasis, alcohol use, hyperlipidemia, hyperparathyroidism, abdominal trauma, viral infections, and certain drugs (particularly diuretics). The presence of gallstones is the most common etiology among pregnant patients; they are found in up to 90% of cases (55–57,59).

Symptoms and Signs

The presentation of pancreatitis is similar in the pregnant and nonpregnant patients. Among cases reviewed by Wilkinson (55), 75% presented with acute abdominal pain. Typically, the pain is of sudden onset and located in the epigastrium. Nausea and vomiting are usually present and may be severe. Very ill patients may present in shock. Generally, the patient is in acute distress. There may be a low-grade fever and a few patients are jaundiced. Epigastric tenderness is the most reliable physical finding. Peritoneal signs are absent or minimal. Bowel sounds are diminished. With severe hemorrhagic pancreatitis, blood may infiltrate the flanks (Grey Turner's sign) or the umbilicus (Cullen's sign).

Laboratory Aids

Serum amylase and lipase should be evaluated in pregnant patients with concern for pancreatitis as would be done for those who were not pregnant. Karsenti et al. in 2001 performed a prospective case-controlled study of serum amylase and lipase controls in normal pregnancy. Their study showed that serum amylase levels are the same in both pregnant and nonpregnant patients. Lipase is different in pregnant patient during the first trimester only and is lower at that time than in nonpregnant patients. They found that during the final two trimesters, there are no significant differences. Their final conclusion was that both amylase and lipase levels should be evaluated in the pregnant patient. They also concluded that serum lipase levels correlated better with acute pancreatitis than did amylase levels (35,60). Elevations of serum amylase also may be seen with intestinal perforation, infarction, or obstruction, and a variety of other conditions.

Other laboratory findings may be hypoglycemia (sometimes severe), hyperglycemia, hyperbilirubinemia, hypocalcemia, hemoconcentration, and electrolyte derangements. Imaging procedures are of limited usefulness for the patient with suspected pancreatitis in pregnancy. Upper abdominal ultrasonography may yield information about concomitant gallbladder disease, but the pancreas is often not well seen. CT or

MRI may be of benefit in severely ill patients with a doubtful diagnosis.

Treatment

The initial treatment of pancreatitis in pregnancy is supportive and does not differ from treatment for the nonpregnant patient. Corrections of hypovolemia, as well as the electrolyte, glucose, and calcium disturbances, are necessary. Oral intake is withheld. If the patient has moderate or severe disease, continuous nasogastric suctioning is often instituted. Total parenteral nutrition may be used if the course of disease is prolonged (61). If gallbladder disease is causative, cholecystectomy or endoscopic papillotomy may be considered once the patient's condition is stable (49).

Course

The mean duration of acute symptoms is about 6 days, but recovery may be prolonged and complicated (55). Estimates of maternal mortality vary widely from 0% to 37%, probably reflecting bias in case selection and improvements in diagnosis and therapy (53,55–57,59). In one compilation of reported cases, the perinatal mortality associated with maternal pancreatitis was estimated to be 38% (55). More recent series indicate a better outlook with perinatal mortality of 11% or less (53,57,59). In a recent review of 43 pregnant patients at one institution from 1983 to 1993, there were no maternal deaths, two stillbirths, and one neonatal death due to prematurity (56). As expected, the risk of perinatal death increased with severity of maternal disease.

INTESTINAL OBSTRUCTION

Occurrence

An increasing frequency of intestinal obstruction during pregnancy has been attributed to a higher rate of intra-abdominal operations, with subsequent adhesions, among women of reproductive age. Rates of occurrence are from 1/1500 to 1/16,000 (35,62). Despite the fact that 50% of pregnant women experience nausea and 33% have problems with emesis, cases rarely occur during the first 4 months of pregnancy (35,63). They are fairly evenly distributed thereafter and into the puerperium. A previous laparotomy, most often appendectomy or an adnexal operation, seems to be the most important risk factor. About one-half of simple intestinal obstruction during pregnancy is due to postoperative adhesions. Volvulus is the next most common condition (9). It, too, may be caused by adhesions. Intussusception is less common. Incarcerated inguinal or femoral hernias, or obstruction resulting from carcinoma, are exceedingly rare among pregnant patients (64).

A special note should be made about pregnant patients who have had gastric bypass surgery. A known risk of this surgery is internal herniation, which can lead to acute bowel obstruction. This may be due to a defect in the mesentery at the jejunal-jejunostomy or a Peterson's defect behind the Roux limb in a Roux En Y gastric bypass. This complication can put a patient and the fetus at serious risk of morbidity and mortality. Any patient who has had bariatric surgery should undergo immediate evaluation when showing signs of obstruction, and surgery should not be delayed if suspicion is high for internal herniation.

Symptoms and Signs

Abdominal pain, vomiting, and constipation are symptoms expected with intestinal obstruction. Almost 90% of affected pregnant patients will have abdominal pain (66). The pain may be constant or periodic. In the third trimester, it may be confused with the pain of labor or placental abruption. Pain may sometimes radiate to the flank, imitating that of pyelonephritis (65). The severity of the pain may not reflect the severity of the disease (67). Patients are often anxious and apprehensive (68). Emesis is a highly variable symptom among patients with intestinal obstruction during pregnancy. With more proximal obstruction, vomiting appears earlier in the course of disease and is more frequent. There may be considerable delay in resumption of emesis after the first episode. Severe obstruction may be present without any vomiting (66). Whereas constipation is a common symptom in pregnancy, complete cessation of stool and flatus is not. Such a report should strengthen suspicion for the diagnosis. With proximal obstruction, bowel movements may continue for a time following the onset of disease. Obstruction may lead to significant dehydration associated with low urine output, mild-to-moderate tachycardia, and hypotension.

Early in the course of disease, physical findings may be subtle. The classic picture of direct abdominal tenderness, distension, and high-pitched tinkling bowel sounds is the exception rather than the rule. Abdominal tenderness may be entirely absent (67). Pressure on the uterus may cause pain when transmitted to distended bowel, misleading the clinician to suspect a uterine process. Abdominal distension is difficult to assess in late pregnancy when the risk for bowel obstruction is the greatest. At presentation, bowel sounds are often described as normal (66). In some cases, particularly with cecal volvulus, a tender cystic mass may be palpable (69,70). Rebound tenderness, fever, tachycardia, and shock are late findings (67).

Diagnostic Aids

Leukocytosis may occur, but is of little help in the diagnosis of intestinal obstruction. Electrolyte abnormalities and hemoconcentration may be present if there has been prolonged emesis or if fluid has accumulated within distended bowel. There may be an elevation of serum amylase levels. Radiographic studies are often essential for diagnosis and should not be avoided out of concern for fetal effects. An upright plain film of the abdomen is the best initial study. Other studies, with or without contrast media, may also be appropriate and should not be delayed if findings on plain films are not typical and suspicion is present. Sequential films may be necessary for proper evaluation of initially normal or equivocal radiologic findings (67).

Treatment and Course

Treatment of intestinal obstruction in pregnancy is the same as that for the nonpregnant patient. Clinical management includes prompt correction of fluid and electrolyte deficits, decompression of bowel, relief of obstruction, and resection of nonviable tissue. Prompt fluid resuscitation is especially important in pregnancy, since uterine blood flow depends upon a normal maternal blood volume. If patients are in shock or significantly impaired, a Foley catheter may be required to

monitor urine output. As fetus mortality is high with bowel obstruction, early surgery is warranted. Adequate operative exposure and thorough inspection of the full length of the bowel should not be compromised. Usually, a midline abdominal laparotomy incision is optimal. In some cases, it may be necessary to empty the uterus to accomplish satisfactory surgical therapy. However, this can most often be avoided (71). As a rule, the treatment of intestinal obstruction is surgical. Selected cases of early sigmoid volvulus have been successfully treated with colonoscopy, long-tube and rectal-tube decompression alone (72). In the case of bowel obstruction, it may not be optimal to attempt a laparoscopic exploration in a pregnant patient. There will be limited exposure due not only to the enlarged uterus but also to the dilated bowel. The bowel may also be friable and easily torn with manipulation causing enterotomies.

The obstetrician should be aware of the entity called colonic pseudo-obstruction, or Ogilvie's syndrome, which tends to occur following cesarean section (73). The clinical presentation is that of large bowel obstruction, but no mechanical stricture or volvulus is present. Radiographs will show marked gaseous distension of the cecum that usually extends to involve the ascending colon and transverse colon. The distal colon and rectum are gasless. Typically, there is little, if any, fluid in the distended bowel and contrast studies reveal no site of mechanical obstruction. If massive distension goes unrelieved, cecal perforation, a life-threatening complication, may occur. Treatment consists of bowel decompression by either colonoscopy or operative cecostomy (74). Neostigmine is an alternative treatment. This agent must be used in a monitored setting with atropine available as it may cause significant bradycardia.

Intestinal obstruction is a serious complication of pregnancy associated with maternal mortality in 10% to 20% and perinatal mortality in 20% to 30% of cases (68,71,75). There are several recent reviews of the topic (76–78). Perdue et al. noted in their review of 66 cases of obstruction that time from the patients' admission to surgery was about 48 hours. Twenty-three percent of patients in that review were found to have dead bowel requiring resection; maternal mortality was 6% and fetal mortality was 26% (78). Intrauterine fetal death and preterm delivery are the most common perinatal complications. Diagnostic vigilance and timely therapy afford the best prospects for a favorable outcome.

URETERAL CALCULI

A case:delivery ratio of approximately 1:1600 has been estimated for symptomatic urolithiasis in pregnancy (79,80). Stone passage seems to occur as often during pregnancy as outside of pregnancy. The causes for urolithiasis are varied. Among 78 women of reproductive age who were evaluated for urolithiasis, 42% had idiopathic hypercalciuria, 13% had hyperuricuria, 10% had primary hyperparathyroidism, 13% had infection stone, 3% had cystinuria, and 19% had idiopathic lithiasis (81).

Pain, usually in the flank but sometimes in the abdomen, is almost always the presenting complaint. Nausea, vomiting, dysuria, urgency, fever, or gross hematuria may be associated. About one patient in four will give a past history of urolithiasis (79,80). Costovertebral angle tenderness is almost always

present. In one series, abdominal tenderness was elicited in 6 of 20 patients (79). Concomitant urinary tract infection may obscure the diagnosis of ureteral calculi.

Microscopic hematuria is found in about 75% of cases. The absence of hematuria at presentation does not rule out a stone. The patient suspected of urolithiasis should be instructed to strain her urine in search of a stone until the diagnosis is clarified. Ultrasonographic imaging of the urinary tract may be helpful in the evaluation of the patient with suspected urinary calculi; the stone, or evidence of ureteral obstruction, may be apparent. Transvaginal ultrasound examination may reveal a distal ureteral calculus (82).

The urinary collecting system, particularly the right side, is often physiologically dilated in the latter half of pregnancy (83). This effect should not be confused with ureteral obstruction. Duplex Doppler waveforms of the intrarenal arteries may help distinguish obstructed from non-obstructed collecting systems, obstruction being associated with a high resistivity index (84). Intrarenal resistivity in pregnancy appears to be no different from that outside of pregnancy, even in the presence of physiologic pelvic dilatation (85). Radiographic evaluation, if needed, may be accomplished with minimal radiation exposure by obtaining a plain abdominal film and a film 20 to 30 minutes after injection of contrast dye. Additional delayed films may be necessary in some cases. If urolithiasis is confirmed, a metabolic evaluation is warranted.

In planning treatment, relevant factors include the size and location of the stone, the degree of obstruction, the severity of symptoms, and the presence of infection. Most calculi will pass spontaneously with hydration. If necessary, minimally invasive treatment options, such as ureteral stent placement, ureteroscopic retrieval, or percutaneous nephrostomy, may be considered (86). These procedures have been safely performed throughout pregnancy (87–89). Open ureterolithotomy is rarely required. Extracorporeal shock-wave lithotripsy has not been approved for use during pregnancy. Unless severe infection complicates the course of urolithiasis, a good perinatal outcome is expected.

ADNEXAL TORSION

Among women requiring laparotomy for adnexal torsion, about 20% are pregnant (90,91). About one-half of the cases of adnexal torsion are associated with an ovarian neoplasm, most often a dermoid cyst. In the reproductive-age group, approximately 2% of cases are associated with ovarian malignancy (90). Gonadotropin-induced ovarian hyperstimulation is a risk factor for torsion and about 16% of affected pregnancies are complicated by adnexal torsion (92). Symptomatic torsion occurs usually in the first, sometimes in the second, but rarely in the third trimester. The right side is involved more frequently than the left (90).

Pain is almost always the presenting symptom, but the nature of the pain is highly variable. The onset may be sudden or gradual. The character may be sharp and intermittent, or dull and constant. In about two-thirds of cases, the pain is unilateral in the lower abdomen. It may be generalized or, uncommonly, it may radiate to the back or flank. Nausea and/or vomiting are present in about half of the patients. Various urinary symptoms are less often reported (91,92). Abdominal

tenderness is the most constant physical finding. Peritoneal signs are variably present. There may be adnexal tenderness or a mass. Leukocytosis may be present, but a normal white blood cell count does not rule out the diagnosis. Ultrasonographic imaging may aid in the identification and characterization of an adnexal mass. Color Doppler sonography may show absent arterial flow in the central ovarian parenchyma. Absent central ovarian venous flow may be a more sensitive finding in cases of adnexal torsion (93). Comparison with the uninvolved contralateral ovary may aid in sonographic diagnosis. Given the nonspecific clinical presentation, it is not surprising that the preoperative diagnosis is often erroneous (90,91).

Torsion of the ovary and/or the Fallopian tube leads to venous congestion, edema, and, ultimately, arterial compromise. The course may be complicated by ovarian rupture or hemorrhage. Some patients report previous episodes of transient pain, indicating that spontaneous reversal of torsion may, at times, occur.

Surgery may be done laparoscopically and is recommended by SAGES guidelines for both diagnosis and treatment of the torsed ovary unless clinical severity warrants a laparotomy (13). The conventional surgical therapy of adnexal torsion is extirpation of the involved tissues, particularly if they appear ischemic or necrotic. If it is necessary to remove the corpus luteum prior to 10 weeks of gestation, there is justification for progesterone supplementation in an effort to maintain the pregnancy. If tissue distal to the site of torsion appears viable, unwinding of the adnexa is an alternative therapy. One group has advocated unwinding, regardless of the appearance of the adnexa, in cases of ovarian hyperstimulation syndrome (94). If the ovary is conserved, the surgeon must be assured that it does not contain a neoplasm. There is little information available to quantify the fetal risk following adnexal torsion. Generally, the pregnancy outcome is good (92).

HERNIAS

Hernias of the abdominal wall or groin are not uncommon in the general population today. Repair of a hernia is one of the most common surgical procedures in the country. Hernias during pregnancy, however, are uncommon, and much less is written about them in the literature. Whenever a pregnant patient has a hernia that is symptomatic, prompt consultation with a general surgeon is prudent.

GROIN HERNIAS

The two most common types of groin hernia are inguinal and, less commonly, femoral. The incidence in women is about 8% to 9% of all groin hernias (95–98). In a retrospective analysis of 21,318 pregnant patients by Ochslein-Kolble et al., it was found that there was an incidence of inguinal hernia during pregnancy of 1/2000. Seventy-five percent of those women were multiparas (99).

Diagnosis

Diagnosis of a groin hernia may be more difficult in a female than a male patient. The standard exam is for palpation of bulge in the inguinal region on valsalva that is either reducible or irreducible. If a bulge is difficult to feel, consideration for an ultrasound should be made. Ultrasound of the groin for hernia evaluation may be more difficult in the

obese or pregnant patient. Occasionally, MRI or CT may be used if clinically warranted to evaluate the groin region. The differential diagnosis for a groin mass includes round ligament varicosity, enlarged lymph node, lipoma, abscess, vascular aneurysm, and of course direct, indirect, or femoral hernias (95,97,99,100).

Treatment

Treatment for an inguinal hernia in a pregnant female varies little from that in a nonpregnant female. If the patient has an acute problem such as incarceration or strangulation of that hernia, emergent treatment should be done. An open inguinal herniorrhaphy may be performed, and if the bowel is found to be nonviable, conversion to an open procedure may be warranted. Mesh may be used for a repair if there is no infection or nonviable bowel. If there is concern for infection, a tissue repair should be performed. In the event that it is not an urgent situation, watchful waiting would be prudent with the repair of the hernia after the pregnancy is complete (97). Buch et al. in their review of 12 patients with inguinal or umbilical hernias during pregnancy showed that repair could be done postpartum with no significant increase in recurrence. Surgery on these patients was done on average at 22 weeks postpartum (97). Reports of inguinal hernia repair at time of c-section have been written. A study by Ochslein-Kolble showed that in eight women who developed an inguinal or umbilical hernia during pregnancy, a tissue repair as a combined procedure with cesarean section was not only feasible but also safe with no recurrences at 56 months (99).

VENTRAL HERNIA

Ventral hernias encompass umbilical, epigastric, and incisional. Incidence of umbilical hernias in pregnancy has been reported to be between 2% and 5%. The incidence of incisional hernias in pregnancy is unknown (95,101,102). Herniation of abdominal contents, uterine fibroids, or the gravid uterus through the hernia defect can be a concern in the pregnant female with a ventral hernia (95,101). If the gravid uterus is incarcerated in the hernia defect, consideration for immediate surgery must be taken due to risk not only of intrauterine growth retardation but also of strangulation of the uterus. In this case, cesarean section is performed with tissue repair of the hernia if possible.

DIAPHRAGMATIC HERNIA

A rare type of hernia that can complicate pregnancy is the diaphragmatic hernia. This type of hernia may be congenital, such as a posterolateral Bochdalek hernia or an anteriomedial hernia of Morgagni, or the more common acquired hiatal hernias.

Signs and Symptoms

Patients with these types of hernias may not know that they have a hernia of the diaphragm until symptoms appear during pregnancy (103,104).

Symptoms may include upper abdominal or chest pain, nausea, and vomiting all of which may worsen as the pregnancy progresses (103,105,106). Patients may also present acutely obstructed with a toxic appearance due to dehydration and herniation of abdominal contents into the chest. These patients may be tachycardic and or have dyspnea (103).

Diagnosis

Diagnosis may be made by an upright anteroposterior and lateral chest X-ray. This may show abdominal contents in the chest with air fluid levels noted in the chest.

Treatment

Management will depend on the acuity of the situation. Due to the increased intra-abdominal pressure exerted by the growing uterus, there is concern that if not repaired during the pregnancy, there may be high morbidity and possibly mortality for the mother and child during the pregnancy or labor. Kurzel et al. in 1988 were emphatic about surgery for this condition stating that in their review of 18 reported cases of this type of hernia, there were 8 maternal and 6 fetal deaths. They felt that repair should be performed prior to labor regardless of whether the hernia was symptomatic or not. Their recommendations for treatment that if there were signs of obstruction, immediate repair should be undertaken regardless of fetal stage of development. If the patient was in the first or second trimester, repair should be done to prevent intra-abdominal contents from pushing into the chest cavity and possibly becoming strangulated. Furthermore, if the patient was asymptomatic in her third trimester, the baby should be followed for fetal maturity. When deemed mature, then elective c-section should be performed with hernia repair done at that time (105).

CONCLUSION

There are many sources of acute abdominal pain in the pregnant patient. Prompt evaluation and coordination between the obstetrician and the general surgeon may make the difference between an excellent outcome and a catastrophe.

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