All gastrointestinal (GI) disorders can present during pregnancy, and in fact 0.2% to 1.0% of all pregnant women require non-obstetrical general surgery [1]. While in general the principles of diagnosing and treating a pregnant woman with an acute surgical abdominal problem remain the same as those governing the treatment of the non-pregnant patient, some important differences are present and can pose problems. As a general rule the condition of the mother should always take priority because proper treatment of surgical diseases in the mother will usually benefit the fetus as well as the mother.

Various anatomic and physiologic changes occur during normal pregnancy, which can alter the presentation of conditions that require surgery: anatomic displacement of the intraperitoneal organs by the gravid uterus, decreased venous return due to pressure exerted on the inferior vena cava by the enlarging uterus, increased cardiac output and heart rate, physiologic anemia, leukocytosis and tachycardia, decreased gastric motility, increased gastric acidity, increased minute ventilation, and decreased functional residual capacity. Diagnosis can be difficult as the enlarged uterus stretches the abdominal wall and compresses the viscera, which results in a diminished response to peritoneal irritation and altered or referred pain perception, making localization of the etiology of the pain more difficult. In addition, various signs and symptoms that normally occur during pregnancy such as morning sickness can be confused with symptoms of acute GI disorders, such as nausea, vomiting, abdominal pain, and dyspepsia.

Proper evaluation and treatment of the pregnant patient requires good clinical acumen, knowledge of the physiologic changes of pregnancy, as well as the most common GI diseases affecting pregnant women. A clear treatment plan that avoids procrastination can be made after careful review of the history, a physical examination performed with the gravid uterus in mind, and judicious use of radiologic studies. If imaging is necessary, sonography should be the screening modality in most cases, and magnetic resonance (MR) imaging can be used in complicated cases. Imaging studies that require radiation such as radiography and computed tomography (CT) can be reserved for those cases where ultrasound and/or MR imaging are insufficient, are difficult to interpret, or are unavailable. It is important to know the radiation doses for tests that are ordered. The estimated dose to the uterus/fetus from a plain film of the abdomen is 250 mrad (2.5 mGy). For CT of the abdomen, the estimated dose to the uterus/fetus is 3000 mrad (30 mGy) [2]. Fetal exposure can be limited in some cases with use of lead shielding of the maternal abdomen.
It is important to have an understanding of the dangers of radiation to the fetus. At 2 to 8 weeks post-conceptual age, the risk of radiation exposure is miscarriage, mental retardation, and malformations. At 8 to 15 post-conceptual weeks, the risk of radiation exposure is neuronal development, mental retardation, and small head size. Somatic effects such as mental retardation have dose thresholds in the range of 5 to 10 rem [3–5]. The excess risk for childhood cancer is estimated at .06%/1 rem [6]. While this risk is small, it is reasonable to avoid radiation exposure when possible. Use of MR, when available, instead of CT, allows for imaging diagnoses to be made without use of ionizing radiation. When MR is not available, it is reasonable to perform CT scans if the radiation exposure is kept to a minimum (i.e., perform the scan only once, with optimal oral preparation and intravenous contrast).

Elective procedures should be delayed until after delivery. The risks of general anesthesia are least during the second trimester, when organogenesis is complete and risk of inducing preterm labor is minimal, so semi-elective procedures should be delayed until this time. Recent reports suggest that the risk of fetal wasting and teratogenicity from gastrointestinal operations during pregnancy are minimal [7–9].

General Guidelines for Surgery During Pregnancy

Non-obstetrical general surgery is not rare and may be required in approximately 1 of 500 pregnancies [1,10]. However, surgery is always very stressful and anxiety-producing for the pregnant woman, even if the outcome is successful. Thoughtful and comprehensive preoperative counseling about dangers to the fetus is an important component of care. Consultation and frequent communication with obstetrical colleagues is crucial. It is important to remember that physiologic changes during pregnancy alter the maternal response to stress. Preoperatively, maintenance of adequate hydration, availability of blood for transfusion, and maternal blood oxygenation and pH to avoid acidosis should be ensured. Deep venous thrombosis (DVT) prophylaxis with intermittent pneumatic compression devices should be employed and fetal monitoring should be done throughout the perioperative period. Tocolytics should be administered only for documented or perceived contractions, not prophylactically.

Intraoperatively, the patient should be placed in the slight left lateral position to prevent uterine compression of the vena cava and left iliac vein. Monitoring of maternal blood gases should be considered, especially for laparoscopic procedures as CO₂ insufflation can induce maternal hypercapnia, which can lead to fetal hypercapnia, tachycardia, and hypertension [11]. Measures should be taken to avoid aspiration as the pregnant patient is at increased risk of aspiration due to decreased gastrointestinal motility and intra-abdominal organ compression. Progesterone also has a relaxant effect on smooth muscle, diminishing esophageal sphincter competency. For laparoscopic surgery, open access using the Hasson technique will minimize potential injury to the fetus and port entry sites should be placed above the level of the uterus. Low-pressure pneumoperitoneum should be used [11]. For open procedures, the uterine size, the specific surgical disorder, and the anticipated type of surgery to be performed will determine the abdominal incision. The uterus should be manipulated as little as possible. Fetal monitoring should be continued in the postoperative period.

Appendicitis

Appendicitis is by far the most common surgical emergency in the pregnant patient. It occurs once in every 1500 to 2000 pregnancies, with approximately equal frequency in each trimester [12]. Management of appendicitis during pregnancy is a surgical emergency and perforated appendicitis is the no. 1 surgical cause of fetal loss during pregnancy. Women who are pregnant have the same risk of developing appendicitis as non-pregnant women. Pain in the right lower quadrant of the abdomen is the most common presenting symptom of appendicitis in pregnancy regardless of gestational age [13]. The signs and symptoms of acute appendicitis are similar to those in non-pregnant patients and include anorexia, nausea, vomiting, and periumbilical pain that migrates to the location of the appendix, although fever and leukocytosis are not clear indicators of appendicitis in pregnancy [13]. Nausea and vomiting may be difficult to distinguish from symptoms due to pregnancy, but localizing right lower quadrant tenderness remains a reliable sign.

Early during pregnancy, peritoneal irritation develops in the right lower quadrant, but after the fifth month of gestation, the appendiceal position and the site of pain is shifted superiorly above the right iliac crest and the appendix is rotated medially by the gravid uterus. The tenderness also becomes less localized as distention of the abdomen lifts the peritoneum away from the inflamed appendix and cecum [14]. Nearly all patients with appendicitis will develop right-sided abdominal pain, and tenderness is still the most important clinical finding. Abdominal guarding, rebound tenderness, and referred tenderness occur in approximately 70% of patients, but guarding is not as reliable a sign given laxity of the abdominal musculature. Rectal or pelvic tenderness is not as common given cephalad movement of the appendix out of the pelvis due to the gravid uterus. In the latter months of pregnancy, the enlarging uterus may interfere with the normal ability of the omentum and bowel to wall off the inflammatory process. Fever is less common (25% of patients) and leukocytosis is difficult to interpret, as this is normal in pregnancy. However, the presence of high band counts should be a clinical clue.

Physical examination on presentation remains the most reliable diagnostic tool, but radiologic studies are sometimes needed to rule out other causes of abdominal pain, such as ovarian torsion, ovarian cysts, degenerating fibroids, pancreatitis, pylonephritis, urethralis, or biliary tract disease. Ultrasound is a safe imaging method, and an accomplished ultrasonographer may be able to locate a swollen or inflamed appendix and look for a periappendiceal abscess (Fig. 1). If an abnormal appendix is visualized, the specificity of sonography is high. However, if the appendix is not visualized, and no other etiology for the pain is found, then other imaging is needed. In these cases MR imaging can be helpful (Fig. 2). MR imaging is felt to be safe for use in pregnancy [15]. According to the Safety Committee of the
Society for Magnetic Resonance Imaging [16], MR imaging procedures are indicated for use in pregnant women if other non-ionizing forms of diagnostic imaging are inadequate, or if the examination provides important information that would otherwise require exposure to ionizing radiation (i.e., x-ray, CT, etc.). According to the American College of Radiology White Paper on MR Safety, “Pregnant patients can be accepted to undergo MRI scans at any stage of pregnancy if, in the determination of a . . . designated attending radiologist, the risk-benefit ratio to the patient warrants that the study be performed” [17]. The White Paper further states that “it is recommended that pregnant patients undergoing an MRI examination provide written informed consent to document that they understand the risk/benefits of the MRI procedure to be performed, the alternative diagnostic options available to them (if any), and that they wish to proceed” [17].

CT can be reserved for complicated cases, or for locations where abdominal MR imaging experience is limited. It should be stressed that in those situations where a diagnosis such as appendicitis is suspected, and sonography is inconclusive or nondiagnostic, and MR is not available, CT is a better choice than subjecting the patient to either a delayed diagnosis or a general anesthetic, which are both associated with a risk of spontaneous abortion.

A high index of suspicion is needed so an early diagnosis can be made, since perforation can lead to a 20% to 25% rate of fetal loss and a 4% maternal mortality, whereas uncomplicated acute appendicitis only results in a fetal mortality of less than 5% [7,18].

A higher rate of negative appendectomy in pregnant compared to non-pregnant patients is acceptable given the potential for worse outcome with perforation. Diagnostic laparoscopy is useful in equivocal cases, and has reduced the rate of false positive appendectomy to 15% [18]. Of note, pyelonephritis is the most common misdiagnosis in patients with acute appendicitis in pregnancy. Once appendicitis is suspected or diagnosed immediate surgical intervention is recommended to avoid perforation. There is no role for non-operative management. Simple acute appendicitis has very little maternal mortality rate and the risk of fetal loss is low, but maternal and fetal complications escalate with peritonitis.

Patients with acute appendicitis should receive preoperative antimicrobial therapy with a cephalosporin and anaer-

---

**Fig. 1.** Sonographic diagnosis of appendicitis in a patient 20 weeks’ pregnant with severe right lower quadrant pain and a white blood cell count of 15.6. Sagittal sonogram demonstrates the enlarged inflamed appendix, measuring 11 mm in transverse diameter. Acute appendicitis was found at surgery. Four weeks later the fetus developed hydrops.

**Fig. 2.** MR diagnosis of appendicitis in a patient 13 weeks’ pregnant with severe right lower quadrant pain in whom sonography failed to show the appendix. Coronal (A) and axial (B) T2-weighted images show an enlarged fluid-filled appendix measuring 9 mm in caliber (arrow). Note the increased signal intensity in the mesoappendix consistent with inflammatory changes (arrowheads). Gravid uterus (U). Mild acute appendicitis was confirmed both at surgery and pathology. Reproduced with permission from Eyvazzedeh et al [92].
Biliary Tract Diseases

Biliary tract disease is the second most common gastrointestinal disorder requiring surgery during pregnancy [18,21]. Pregnancy predisposes to gallstone formation and gallstones occur in approximately 7% of nulliparous women but in 19% of women with two or more pregnancies [22]. Gallstones and sludge are most likely caused by biliary stasis, prolonged intestinal transit, and increased cholesterol saturation of bile. The frequency of biliary colic during pregnancy is controversial, and the recommended therapeutic approach is conservative. One to eight of 10,000 pregnant women will suffer from acute cholecystitis and, when required, invasive procedures are well tolerated, especially when performed during the second trimester [23]. Maternal and fetal complications are uncommon and the likelihood of fetal demise or preterm delivery is minimized when elective operations are done in the second trimester. Infection, pancreatitis, gallbladder rupture, or inappropriate delays can lead to increased rates of fetal mortality [24].

The symptoms of biliary tract disease are very similar to those seen in non-pregnant patients. Common symptoms include anorexia, nausea, and vomiting, along with abdominal pain in the midepigastrium, right upper quadrant, or shoulder. Right upper quadrant tenderness and a Murphy’s sign are important findings. Laboratory values may reveal an elevated alkaline phosphatase or bilirubin level, Jaundice, abnormal transaminases, or hyperamylasemia can be a sign of complicated biliary tract disease [25]. Differential diagnoses include appendicitis, pancreatitis, peptic ulcer disease, pyelonephritis, and HELLP syndrome (Hemolysis, Elevated liver enzymes, Low Platelets) with hepatic rupture [26]. A right upper quadrant ultrasound should be performed and is accurate 97% of the time in diagnosing cholecystitis. The ultrasonographic signs of acute cholecystitis remain the same during pregnancy and include gallbladder wall edema, pericholecystitis fluid, an ultrasonographic Murphy’s sign or biliary ductal dilatation [27]. If extrahepatic ductal stones are suspected, and ultrasound fails to adequately demonstrate the extrahepatic duct, then MR cholangiography can be performed. Endoscopic retrograde cholangiopancreatography (ERCP) with its associated radiation exposure can be performed only in cases where treatment is needed for documented ductal stones. The dose from an ERCP in pregnancy can be kept to safe levels of approximately 310 mrad [28].

Initial management of biliary tract disease in the pregnant state includes discontinuing oral intake, and providing antibiotics and analgesia as well as adequate hydration. Patients who fail to respond to medical therapy or have repeated bouts of biliary colic requiring hospitalization should undergo an operation, which is best deferred to the second trimester if feasible.

Laparoscopic cholecystectomy can be performed safely in most pregnant patients, especially during the first 2 trimesters [7,24,29] and advantages include less pain and a quicker recovery compared to an open procedure. An open entry technique is probably safest, although use of the Veress needle with alteration of the entry site has been reported to be safe [7]. All port entry sites should be adjusted to avoid injury to the gravid uterus. During laparoscopic cholecystectomy, the maternal end tidal CO2 or arterial CO2 levels should be measured and temporary desufflation of the pneumoperitoneum should be performed if levels are rising, since hypercarbia can lead to fetal acidosis. Conversion to open cholecystectomy should be considered if CO2 levels are rising, there is poor visualization, or a prolonged procedure is expected. Routine cholangiography is not advocated, but the biliary system can be assessed by intraoperative ultrasound. If cholecdocholithiasis is found or highly suspected, this can be approached laparoscopically, with an open common duct exploration, or with postoperative ERCP [30]. MR cholangiography and laparoscopic common bile duct (CBD) exploration have also been reported as options in the management of CBD stones [31]. The apparent safety of ERCP with endoscopic sphincterotomy for stone extraction or stent insertion also has been addressed in these reviews [32]. If endoscopic stone extraction is performed, the fetus should be shielded during fluoroscopy.

Pancreatitis

Pancreatitis occurs more frequently in the third trimester and the immediate postpartum period compared to earlier in the pregnancy [10]. Management for the most part is nonoperative, as in any other patient with pancreatitis [33]. The general principles of treatment remain the same, including bowel rest with or without nasogastric suction, intravenous fluid and electrolyte replacement, and parenteral analgesics. Most cases of pancreatitis during pregnancy are the result of gallstone disease [10]. Signs and symptoms are essentially the same as those in the nongravid state and can include severe abdominal pain radiating to the flank associated with nausea, vomiting, and hyperamylasemia. Diagnosis can be difficult as there is a physiologic increase in serum amylase during pregnancy. A serum amylase that is greater than 2 times above the upper limit of normal suggests pancreatitis. Serum lipase also may be helpful in the differential diagnosis. Important additional measures in the pregnant patient are fetal monitoring, attention to the choice of medication, avoidance of radiation to the fetus, and positioning the mother to prevent potential deep venous thrombosis. Paren-
teral nutritional supplementation should be considered to protect the fetus. Ultrasound can be used to visualize dilated pancreatic ducts and pseudocysts and focal accumulations larger than 2 to 3 cm but is limited by operator skill, obesity, and bowel dilatation [34]. CT scanning is generally not needed unless severe necrosis of the pancreas is suspected [34]. Surgical intervention is reserved for patients with infected pancreatic necrosis of the pancreas, ruptured pseudocyst, severe hemorrhagic pancreatitis, or persistent biliary obstruction, which is not amenable to ERCP clearance. Early surgical intervention is recommended for gallstone pancreatitis in all trimesters [1,35]. This is supported by evidence that more than 70% of patients with gallstone pancreatitis will relapse before delivery [33]. Both laparoscopic and open cholecystectomy have been performed safely for gallstone pancreatitis throughout gestation [35–37]. Perioperative fetal monitoring and low pneumoperitoneum pressures are suggested [35]. Although ERCP has a clear role in managing this condition in nongravid patients, its use in pregnancy is limited because of radiation exposure to the fetus [38,39]. To avoid radiation, videoendoscopy and ultrasound guidance are being developed for use in ERCP during pregnancy [38]. Antibiotics are not recommended for patients with gallstone pancreatitis [34]. Management of pancreatic pseudocysts in pregnancy remains controversial. Endoscopic stenting and percutaneous drainage has not been shown to be effective for pseudocysts greater than 5 cm [40]. As in nongravid patients, pseudocysts less than 5 cm in diameter tend to resolve spontaneously.

Trauma

Pregnancy can be complicated by trauma such as motor vehicle accidents, falls, or assaults. The approach to the pregnant patient who suffers blunt or penetrating abdominal trauma should follow the principles of Advanced Trauma Life Support (ATLS) used for all patients. The mother must be properly stabilized in order to protect the fetus. Close attention to airway, breathing, and circulation—the "ABC's" of trauma management—remains the most important principle. In addition, fetal monitoring should be instituted promptly and not delayed until the patient reaches the obstetric area of the hospital [41]. Fetal monitoring should continue for at least 24 to 48 hours if there are frequent uterine contractions, vaginal bleeding, abdominal tenderness, postural hypotension, or fetal heart rate abnormalities. Fetal death is more likely with greater severity of maternal injury and with mechanisms of injury such as ejection from a vehicle, motorcycle and pedestrian collisions, or assaults. Maternal death, maternal tachycardia, or abnormal fetal heart rate are all significant risk factors for increased fetal death [42,43].

The first step in fetal monitoring is the assessment of fetal heart tones by Doppler or ultrasonography. Monitoring should only continue if fetal heartbeat is present. Gestational age should then be determined. This is most accurately performed by ultrasound. Electronic fetal monitoring should only be continued in a viable fetus (at least 24 to 26 weeks of gestation and 500 g) because no obstetric intervention will alter the outcome of a pre-viable fetus.

It is important to initiate monitoring as early as possible after maternal stabilization because most placental abruptions occur shortly after trauma. Placental abruption is associated with at least 8 uterine contractions per hour for more than 4 hours and, after trauma, carries a 65% to 75% risk of fetal mortality. Significant placental abruption requires immediate delivery of the fetus [42,44,45]. Fetal monitoring can be discontinued after the first 4 to 6 hours if there are no complications during this interval since most placental abruptions occur shortly after trauma [42,44–46].

Both ultrasound, using the FAST technique (Focused Abdominal Sonography for Trauma), and abdominal CT scanning are important tools in the evaluation of the pregnant trauma patient. The sensitivity and specificity of abdominal ultrasonography in pregnant trauma patients is similar to that seen in non-pregnant patients [47]. Ultrasound is especially useful for detecting fetal distress, while CT can demonstrate uterine rupture and retroperitoneal hemorrhage as well as concurrent evaluation of other organs in the pregnant trauma patient [43]. A Kleihauer-Betke test may show evidence of fetomaternal hemorrhage and is recommended for Rh-negative patients [10]. Blood transfusion, if necessary, should be cross-matched; if time is of the essence, non–cross–matched O negative blood should be given to avoid antibodies to Rh and sensitization in future pregnancies.

Intestinal Obstruction

Intestinal obstruction is the third most common nonobstetric reason for laparotomy during pregnancy (following appendicitis and biliary tract disease). It complicates 1 in 1500 to 3000 pregnancies and is caused most commonly by adhesions.

Its incidence increases as pregnancy progresses with most cases occurring in the third trimester [10], with few cases in the first trimester, and the remainder split almost equally between the second trimester and 6 weeks following delivery [48–50]. Acute abdominal pain and vomiting and obstruction from intestinal obstruction in pregnancy can be caused by adhesions, volvulus, intussusception, hernias, or neoplasm.

Intussusception from non-Hodgkin’s lymphoma is infrequently diagnosed during pregnancy. The diagnosis of intestinal obstruction is confirmed with a serial acute abdominal series. Volvulus should be suspected when there is a single, grossly dilated loop of bowel. Persistent abdominal pain aggravated by changes in position and by increases of intra-abdominal pressure should always be investigated, even when a bulge or specific hernial defect is not clinically appreciable. Ultrasound can sometimes demonstrate the hernia defect. Physicians caring for the pregnant woman must be aware that all abdominal conditions can occur despite the pregnant condition. The management of bowel obstruction in pregnancy is essentially no different from treatment of non-pregnant patients and includes decompression, intravenous hydration, and timely surgery [51–55].

Splenic Artery Aneurysms

Splenic artery aneurysms are quite rare, but they are more common in women. Rupture of a splenic artery aneurysm is a catastrophic event, most commonly associated
with pregnancy and usually presents as sudden unexpected shock or death. Half of the cases of rupture occur in patients less than 45 years of age and a quarter of all cases are in pregnant women, usually in the third trimester or during labor. They are usually asymptomatic until rupture, although occasionally they are recognized by vague symptoms such as left upper quadrant or epigastric pain. In some cases, an audible bruit over the left hypochondrium can be appreciated or the aneurysm can be seen on plain x-ray of the upper abdomen as a calcified ring with a central lucent area to the left of the first lumbar vertebral body. They can also be identified on ultrasound or abdominal CT scan. If found, splenic artery aneurysms should be treated electively to avoid rupture, with splenectomy and resection of the artery, exclusion of the aneurysm or angiographic embolization [56]. If rupture is suspected, immediate laparotomy should be undertaken with ligation of the splenic artery and resection of the aneurysm and splenectomy. As in the non-pregnant patient, pneumococcal vaccine should be given 2 weeks prior to elective splenectomy or immediately following emergent splenectomy.

Hepatic Lesions

Pregnancy is associated with increased growth and risk of rupture of hepatic adenomas. Hepatic adenomas are usually solitary, but multiple lesions have been reported. The association between oral contraceptives or other hormone therapies and the development of adenomas is well established. The risk of rupture during pregnancy probably relates to the expanded blood volume and an increase in venous blood pressure. Liver hemangiomas are also related to estrogen, and pregnancy may stimulate enlargement or increase the risk of rupture. Most patients can be treated conservatively with frequent sonographic monitoring of the fetus and the hemangioma.

Adenomas greater than 5 cm in size should be resected; those smaller than 5 cm should be observed with serial ultrasounds and resected if rapid growth is noted [57,58]. There are no reports of maternal mortality from resection. Women with nonresected adenomas require close postpartum follow-up [57]. Surgical intervention is indicated in cases of worsening symptoms, rapidly growing lesions, Kassabach-Merritt syndrome, and rupture [57,59].

Imaging of a liver mass during pregnancy is initiated with an ultrasound study. A cystic mass requires no further work-up. A solid liver mass should be further evaluated with MR imaging without contrast. MR imaging has 100% sensitivity and 92% specificity for detecting a hemangioma. MR imaging can be followed with technetium-99m red blood cell scan to ascertain the diagnosis of hemangioma. CT scans are rarely used during pregnancy due to potential harm to the fetus from ionizing radiation. When a hemangioma is ruled out with the imaging techniques, percutaneous needle biopsy may be necessary to establish a final diagnosis [57].

Acute fatty liver of pregnancy and the HELLP syndrome are rare but major disorders of pregnancy. Both are associated with a history of preecclampsia and are generally seen in the third trimester [60]. Subcapsular hemorrhage and hepatic rupture are unusual and potentially fatal complications of the HELLP syndrome. A high index of suspicion and prompt recognition are keys to proper diagnosis and management of affected patients. An aggressive multidisciplinary approach is called for in these high-risk situations [61]. Surgical principles for control of bleeding are followed and techniques such as packing of the liver, deep mattress sutures, or omentoplasty can be employed. In severe cases, liver transplantation has been successfully performed [62,63].

Hemorrhoids

Hemorrhoids in pregnancy are due to increased circulating volume, increased venous congestion caused by compression of the superior rectal veins by the pregnant uterus, as well as the relaxing effect of progesterone on the smooth muscle in the walls of the veins [10]. Hemorrhoids can present with bleeding, prolapse, mucoid discharge, pruritus, and rectal discomfort. It is important to exclude other causes of these symptoms such as inflammatory bowel disease, anal fissure, and carcinoma of the colon, rectum, or anus. Sigmoidoscopy and colonoscopy can be done safely in pregnancy [32,64]. Treatment is non-operative in most cases and includes dietary fiber, psyllium, stool softeners, increased fluid intake, avoidance of straining, and hemorrhoidal analgesics. Rubber band ligation can be performed for internal hemorrhoids. If the hemorrhoids are severely prolapsed or have associated ulceration, severe bleeding, fissure, or fistula and symptoms fail to respond to conservative measures, hemorrhoidectomy should be considered. Thrombosed external hemorrhoids can be treated with simple clot extraction or if straightforward with excision of the thrombosed external hemorrhoids, which reduces the chance for recurrence.

Inflammatory Bowel Disease

Most pregnant women with a history of inflammatory bowel disease have uneventful pregnancies and exacerbations of disease can be controlled with medical therapy. It is rare for the new onset of inflammatory bowel disease to be diagnosed during pregnancy [65]. The new diagnosis of Crohn’s disease in pregnancy is difficult as the symptoms are often nonspecific and are similar to those seen in normal pregnancy [65]. There is often a delay in diagnosis and treatment, which contributes to a poor prognosis.

Many patients with a history of ulcerative colitis managed with ileal pouch anal anastomosis (IPAA) will become pregnant. Long-term outcomes of pregnancy and vaginal delivery in females with ulcerative colitis before and after IPAA are positive [66]. Early intervention involving appropriate radiographic studies, antibiotic treatment, and surgical management is recommended in pregnant patients with a history of IPAA [67].

When relapses of Crohn’s disease do occur during pregnancy, they usually present during the first trimester. Abscess is less well controlled in pregnancy and there is a higher frequency of free perforation. For this reason, patients presenting with peritoneal signs should undergo operation without delay. Resection of the source of the sepsis and exteriorization of the bowel ends rather than anastomosis is recommended as an anastomotic leak can prove catastrophic in a pregnant woman, putting both the mother and
fetus at increased risk [68]. Imaging can start with ultrasound, but frequently another modality is needed, such as MR or CT (Fig. 3).

A minority of pregnant women with ulcerative colitis will need surgery for toxic megacolon [69,70]. In such cases, a limited surgical procedure may be desirable to reduce the risk of maternal and fetal mortality. The “blow-hole” colostomy and loop ileostomy (Turnbull procedure) has been used successfully in the management of toxic dilation of the colon complicating ulcerative colitis in pregnancy. Completion proctocolectomy and ileal pouch-anal anastomosis can be completed after delivery [71]. A successful 3-stage procedure involving subtotal colectomy with diverting ileostomy during pregnancy, proctectomy with an ileal J-pouch anal anastomosis after delivery, and ileostomy closure last also has been reported [72].

**Colorectal Malignancy**

Colon cancer during pregnancy is very rare as these tumors are uncommon before age 40 [73,74]. The majority of cases of colorectal carcinomas in pregnant women arise from the rectum [75]. This may simply reflect a detection bias by a tendency toward rectal examinations during prenatal care [76]. Delayed diagnosis is common because of similarity between GI complaints common in pregnancy and early signs and symptoms of colon cancer. Digital rectal examination, tests for occult blood, and flexible sigmoidoscopy followed by colonoscopy should be performed for complaints consistent with colonic disease. Digital rectal examination and sigmoidoscopy can be expected to reveal greater than 80% of colorectal tumors in pregnant patients [77]. MR imaging has been used to diagnose colon cancer in advanced pregnancy [78]. Hepatic ultrasound is a sensitive modality for detecting liver metastases in pregnancy [80]. Carcinoembryonic antigen (CEA), a useful tumor marker for colon cancer, may be elevated during pregnancy and therefore is of little value [75].

Treatment of colorectal cancer follows the same general guidelines as for non-pregnant patients [79]. Primary surgical treatment should be performed whenever it is indicated. Later in pregnancy, it is preferable to delay surgery to allow fetal maturation and delivery. Stage for stage the survival data are the same for pregnant patients and non-pregnant controls; however, diagnosis is often delayed due to pregnancy-associated gastrointestinal symptoms masking cancer symptoms [79].

With respect to colon cancer, many authors recommend primary surgical treatment during the first half of the pregnancy because delaying treatment until after delivery may result in tumor spread. Therefore, in the first half of pregnancy, primary resection and anastomosis are advised. Hysterectomy is not necessary to safely perform colon or rectal resection so therapeutic abortion is not mandated [79]. If the cancer is stage I, II, or IV, the pregnancy may be carried to term and the stoma may be closed later [80]. If the lesion is unresectable or is obstructing in nature, a colostomy should be performed to help provide time for the fetus to reach viability [81,82]. Stage III carcinomas are treated with chemotherapy after delivery as in non-pregnant patients [83,84]. Hysterectomy is advised when the mother’s life expectancy is less than the time required for the fetus to reach viability, if the uterus is involved, or greater access to the rectum is needed for a technically complete operation [82,85].
Postpartum colorectal surgery is recommended for patients presenting in the second half of pregnancy [80,83]. Delivery may be induced when the fetus is viable and treatment may continue as in a non-pregnant patient [80]. Elective cesarean section is often preferred because colonic resection and staging procedures can be done concurrently [84]. If cesarean delivery is required for obstetric reasons, proceeding with resection of colon carcinoma after primary cesarean section should be considered if the patient is medically stable, no significant complication of cesarean section has occurred, and exposure is adequate. Proctectomy should always be delayed [80]. If surgery is delayed until the postpartum period, it should be performed after the gravid uterus and pelvic vascularity have regressed to improve accessibility to the tumor and reduce the risk of bleeding and thromboembolic complications [81–83,85]. Proper staging, including transrectal ultrasonography, can be performed while awaiting involution of the uterus [82].

Colon cancer in pregnancy is complicated by ovarian metastases in up to 25% of cases [86]. Several authors have reported that 22% to 23% of women younger than 40 years with colorectal tumors have ovarian metastases [87,88]. Because of the high incidence of metastases to the ovary, bilateral ovarian biopsies with frozen sections are recommended. Bilateral salpingo-oophorectomy (BSO) is performed when the ovaries are involved or if hysterectomy is done for other indications [81]. However, Nesbitt et al reported that BSO at the time of resection during pregnancy may increase the chance of spontaneous abortion, particularly in the first trimester [85]. Instead, they recommend bilateral ovarian wedge biopsies with frozen sections and removal of the ovaries only if there is evidence of tumor or if hysterectomy is performed for other reasons [85].

Rectal cancer presenting in pregnancy is managed somewhat differently than colon cancer. During the first 20 weeks of pregnancy, patients wishing to carry their pregnancies to term may elect to have primary resection followed by chemotherapy after delivery [83]. If the patient chooses to terminate the pregnancy, she may be managed as a non-pregnant patient after therapeutic abortion. Stage II and III tumors are treated with chemotherapy after resection. During the second half of pregnancy, treatment is withheld until after delivery. Rectal tumors below the pelvic brim may interfere with vaginal delivery and necessitate cesarean delivery. In advanced rectal tumors, preoperative radiation therapy may have some benefit after delivery while awaiting involution of the uterus [82]. Patients who have liver metastases at diagnosis should be treated with chemotherapy [84].

Cancer complications such as hemorrhage, obstruction, or perforation may necessitate surgical intervention [79]. In patients presenting with bowel obstruction or perforation, decompressive measures should be used as an initial therapy. During the first half of the pregnancy in an emergency situation (obstruction, perforation, hemorrhage), Walsh and Fazio recommend resection and stoma [77,80]. Hartmann’s operation is recommended for patients in an emergent situation presenting with rectal cancer early in pregnancy [80]. Obstructing rectal tumors discovered late in the pregnancy should be treated by proximal diversion followed by curative resection several weeks after delivery [77]. Controversy exists regarding cesarean section during laparotomy via an infected peritoneal cavity in the setting of perforation [81].

Chemotherapy for colorectal cancer does not offer sufficient benefit to the mother to warrant the risk to the fetus [76]. Chemotherapy is contraindicated during the first trimester of pregnancy. Adjuvant chemotherapy can be employed late in pregnancy in a patient who has undergone colorectal resection early in pregnancy [80]. Radiation therapy is contraindicated in all trimesters and should be restricted for use in rectal cancer in non-pregnant patients who do not desire further pregnancies because of the resulting permanent and irreversible sterility [80,89,90].

A cancer diagnosis during pregnancy is a challenging and potentially devastating situation for the pregnant woman and her family, who are faced with simultaneous life-giving and life-threatening processes [91]. In these situations, close attention to the psychological needs of the patient and her family is as important as meticulous medical care. An interdisciplinary team approach is recommended with close collaboration between the obstetrician, surgeon, oncologist, neonatologist, and pediatrician. Involvement of the nursing staff, social worker, chaplain, and an ethicist may be useful as well [91].

**Summary**

All GI disorders can present during pregnancy, and in fact .2% to 1.0% of all pregnant women require non-obstetrical general surgery [1]. All of the clinical decision-making skills of the experienced surgeon must come into play in order to make the correct therapeutic decisions when evaluating the pregnant patient with a GI disorder that potentially requires surgery. While in general the principles of diagnosing and treating a pregnant woman with an acute surgical abdominal problem remain the same as those governing the treatment of the non-pregnant patient, some important differences are present and can pose problems. As a general rule the condition of the mother should always take priority because proper treatment of surgical diseases in the mother will usually benefit the fetus as well as the mother.

**References**


