Chapter 27
Surgical Emergencies During Pregnancy

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Acute abdomen can be defined as "any serious acute intra-abdominal condition attended by pain, tenderness, and muscular rigidity, and for which emergency surgery must be considered" [1]. Acute abdomen during pregnancy, without an obstetric cause, occurs in 1/500–635 pregnancies [2]. For some conditions, the predisposing factors are known in both the general and the pregnant population, such as acute cholecystitis. In other, such as acute appendicitis, the predisposing factors are not known.

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27.1 Acute Appendicitis

27.1.1 Incidence

Acute appendicitis is present in 1/500–2000 pregnancies (which amount to 25 % of operative indications for the acute abdomen in pregnancy) [3].

27.1.2 History and Examination

The following features suggest acute appendicitis [3]: (1) severe abdominal pain, (2) pain in the right lower quadrant – the most reliable symptom, (3) nausea (nearly always present), (4) vomiting (2/3 of patients), and (5) after the third month of pregnancy, the pain could migrate progressively upward and laterally.

Abdominal tenderness is almost always present, rebound tenderness in 55–75 % [4], and abdominal muscle rigidity in 50–65 % of patients [3]. The psoas sign is observed less frequently during pregnancy when compared with the nonpregnant woman [5]. Fever and tachycardia may be present, but these are not sensitive signs.

27.1.3 Investigations

Leukocytosis is not diagnostic because it raises in the second and third trimesters and can reach 20×10^9/l in early labor in normal pregnancy. A raised C-reactive protein (CRP) is not specific but the increase correlates with the disease severity. Neutrophil granulocytosis with left shift is diagnostic and indicates bacterial infection. Pyuria (pus in the urine) is observed in 10–20 % of patients [6]. This may also represent concurrent asymptomatic bacteriuria.

There are no Royal College of Obstetricians and Gynaecologists guidelines about the use of transvaginal ultrasound but it can define [7]: (1) the presence of adnexal or uterine pathology ruling out acute appendicitis, (2) free fluid in the pouch of Douglas, and (3) abnormal pathology in the ileocecal region – appendicitis, cecal tumors, or cecal diverticulitis.

Abdominal ultrasound is the modality of choice with variable sensitivity and specificity [8]. It has good accuracy in the first and second trimesters with less accuracy in the third.

Magnetic resonance imaging (MRI) is the modality of choice when the risk of radiation or the potential nephrotoxicity of iodinated contrast agents is a major concern [9, 10]. The patient's informed consent is mandatory; the safety of MRI for the fetus has not been proved according to the US Food and Drug Administration (FDA) guidelines and the American College of Radiology [9]. Thus, it is prudent to perform an MRI in pregnant patients only when ultrasound findings fail to establish a diagnosis.

The computed tomography (CT) scan is used when there is an uncertain clinical diagnosis or equivocal laboratory or ultrasound findings, or where access to MRI is limited. It is preferable to use the multidetector row CT scan with high-speed mode since it has half the radiation dose of the high-quality mode and its scanning parameters are otherwise identical.

27.1.4 Management

Management is surgical either by laparotomy or by laparoscopy. Even if the appendix appears normal, there are two reasons for removal: (1) early disease may be present despite its grossly normal appearance and (2) diagnostic confusion can be avoided if the condition recurs. Despite the surgical approach, the most experienced abdominal surgeon should perform the procedure to shorten the operation time and possible postoperative complications as much as possible.

Open appendectomy can be performed by: (1) muscle splitting incision (McBurney's incision), (2) midline vertical incision (this allows the surgeon to deal with unexpected surgical findings and for a Cesarean delivery if necessary), and (3) right pararectal incision. Despite the type of incision, the operation should be completed with minimal uterine manipulation.

Laparoscopic appendectomy is made in the first and second trimesters, and is recommended when the diagnosis is uncertain. The open (Hasson) technique is recommended and the cannula introduced 2–4 cm cranially from the palpable uterine fundus. It minimizes the complications of entering the abdomen and uterine or fetal injuries. If injury occurs, the ultrasound scan determines the presence of a fetal heart rate and residual amniotic fluid volume. With a live fetus and enough amniotic fluid, the gestation could be continued. Contamination of amniotic fluid with purulent or feculent material (possible chorioamnionitis) is addressed by the use of perioperative broad-spectrum antibiotics.

27.1.5   Prognosis

Pathological confirmation of inflamed appendix is found in about 67 % of patients [11]. Appendix in pregnant patient should always be removed since pregnancy is not affected by removal of a normal appendix [12].

Fetal mortality when the appendix is not perforated is 1.5–5 % [13, 14], while when perforated, fetal mortality rises to 20–35 % [13, 15]. Maternal mortality is less than 1 %. It is rare in the first trimester, and increases with advancing gestational age [12]. It is associated with: (1) a delay in surgery of more than 24 h [16, 17], and (2) appendiceal perforation – maternal mortality in up to 4 % [15, 18].

27.2 Acute Cholecystitis

27.2.1 Incidence

Acute cholecystitis is found in 1/1600–10,000 pregnancies. It is caused by gallstones in over 90 % of patients. The incidence of symptomatic and asymptomatic gallstones is 3.5–10 % in primiparous women, and up to 19 % in multiparous women [19].

27.2.2 History and Examination

Features suggesting acute cholecystitis are [20]: (1) a history of previous episodes of acute cholecystitis; (2) a history of nausea, dyspepsia, and an intolerance of fatty foods; (3) vomiting (in 50 % of patients); (4) abdominal pain in the right hypochondrium or epigastrium; and (5) pain also radiating to the back and around to the right scapula.

Abdominal tenderness on direct palpation and Murphy's sign are present. The rigid abdomen is found with gallbladder perforation and biliary peritonitis. Fever and tachycardia may not be present and so are not sensitive signs.

27.2.3 Differential Diagnosis

In decreasing incidence it includes: pyelonephritis, pancreatitis, peptic ulcer disease, acute appendicitis, pre-eclampsia, pneumonia, acute fatty liver of pregnancy, HELLP syndrome, myocardial infarction, and herpes zoster.

27.2.4 Investigations

Leukocytosis is not diagnostic because it is raised in the second and third trimesters and can reach 20×10^9/l in early labor in normal pregnancy. A raised CRP correlates with the disease severity. Neutrophil granulocytosis with left shift indicates bacterial infection. Bilirubin and transaminases may be elevated, but are not specific. Raised alkaline phosphatase is also not helpful as estrogen causes elevation (levels may double during normal pregnancy). Serum amylase is transiently raised in up to 33 % in pregnant and nonpregnant women.

Gallstones are diagnosed by abdominal ultrasound in 95–98 % of patients [21]. If gallstones without wall thickening are found, then the diagnosis is biliary colic, not acute cholecystitis. In acute cholecystitis, findings include: (1) gallbladder calculi, (2) wall thickening (>3 mm), (3) pericholecystic fluid, (4) sonographic Murphy's sign (focal tenderness under the ultrasound transducer when it is positioned over the gallbladder), and (5) dilation of the intra- and extrahepatic ducts when the common bile duct is obstructed.

Magnetic resonance cholangiography is used if dilation of the intra- and extrahepatic ducts is found on abdominal ultrasound, especially when the cause of the dilatation is not certain.

27.2.5 Management

Medical treatment is commonly used initially, especially with biliary colic. It consists of a low-fat diet, analgesia, antibiotics, and anticholinergic antispasmodics such as dicyclomine. Patient should be admitted to hospital for a week, and then followed-up

weekly. A second reason for conservative therapy is to delay surgery until the second trimester because the spontaneous abortion rate after open cholecystectomy is 12 % in the first, and only 5.6 % in the second trimester. Nonsteroidal anti-inflammatory drugs, such as ibuprofen, naproxen, or diclofenac can be used for pain relief. Paracetamol and weak opioids such as codeine are used if nonsteroidal anti-inflammatory drugs are not tolerated or are contraindicated. First-line treatments are ampicillin and sulbactam, cefoxitin, or cefuroxime (US FDA category B).

Recommendations for early and initial surgery are based on [22]: (1) reduced likelihood of recurrence – the recurrence rate during pregnancy is around 50 % [23]; (2) avoidance of medications during pregnancy; (3) elimination of potentially life-threatening complications – perforation, sepsis, and peritonitis; (4) lowering the incidence of gallstone pancreatitis, which causes fetal loss in 10–20 % of patients; and (5) lowering the incidence of spontaneous abortions, preterm labor, and preterm delivery.

Open cholecystectomy is performed by right subcostal incision or an upper midline incision. The Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) published guidelines in 2007 that stated '*Laparoscopic cholecystectomy* is the treatment of choice in the pregnant patient with gallbladder disease, regardless of trimester' [24].

27.2.6   Prognosis

Prognosis is excellent because inflammatory disease is mostly away from the uterus. If outcomes are compared, laparoscopic access has significant advantages in all outcomes measured.

27.3 Intestinal Obstruction

27.3.1 Incidence

Intestinal obstruction is found in 1/1500–16,000 pregnancies [25]. The most common cause are adhesions, present in 60–70 %. They arise following previous abdominal or pelvic surgery, or pelvic inflammatory conditions [26]. The second most common cause is large bowel volvulus, which occurs in 25 % of pregnant patients (it is the cause in only 3–5 % of non-pregnant patients). Cecal volvuli are found in 25–45 % of large bowel volvuli. Other causes include small bowel volvulus (in 9 %), intussusception (in 5 %), and other rare conditions such as hernia, cancer, and diverticulitis.

Rapid changes in uterine size can cause obstruction; at 16–20 weeks the uterus becomes an intra-abdominal organ, at 32–36 weeks the fetus enters the pelvic inlet, and at the puerperium the uterus involutes and shrinks rapidly again. The redundant or abnormally mobile colon is predisposed to torsion or twisting because of uterine pressure [27].

27.3.2 History and Examination

Features suggesting intestinal obstruction are [26]: (1) previous episodes of colicky abdominal pain; (2) abdominal pain is observed in 90 % of patients and may be constant or periodic, mimicking labor; (3) nausea and vomiting; vomiting is not always present, but if the obstruction is more proximal, vomiting occurs earlier; and (4) constipation, different from the usual constipation in pregnancy; there is complete cessation of stool and flatus.

The abdomen is distended and tender on palpation. Hyperperistalsis is found early on, but later there is a complete

absence of peristalsis. Palpation of the uterus often causes pain secondary to transmitted pressure to the bowel, misleading that the problem is in the uterus. Rebound tenderness, fever, and tachycardia occur late and suggest peritonitis. Examine hernia orifices for protrusions and contents. If present and irreducible, incarcerated hernia is the cause of the obstruction. With digital rectal examination, the presence of intrarectal or perirectal masses, such as stenosis, rectal cancer, or rectal prolapse, should be confirmed or ruled out.

27.3.3   Investigations

Leukocytosis is not diagnostic because it is raised in the second and third trimesters and can reach 20×10^9/l in early labor in normal pregnancy. The CRP correlates with the severity of obstruction, incarceration, and strangulation. Neutrophil granulocytosis with left shift is present. Electrolyte abnormalities are common due to dehydration, vomiting, and fluid shift into the bowel lumen. Elevated serum amylase is not specific.

The significant maternal and fetal mortalities associated with obstruction outweigh the potential risk of fetal radiation exposure. Plain abdominal X-rays are needed every 6 h if the obstruction is partial and in the absence of clinical improvement [26]. Contrast studies are needed if there is an absence of typical findings on plain abdominal films.

Colonoscopy can be therapeutic and result in the reduction of a sigmoid volvulus in 60–90 % of patients. The chance of reduction of cecal volvulus is low. There is more than a 50 % of recurrence of both sigmoid and cecal volvuli, which means that delayed surgery (fixation or resection) after delivery is mandatory [28]. Bloody intestinal contents or cyanotic mucosa suggests ischemia and are indications for emergent laparotomy.

27.3.4   Management

Medical management is started once the diagnosis is established, regardless of the completeness of the obstruction. Vomiting can cause large losses of fluid and electrolytes. Moreover, during obstruction a large volume of fluid is contained within the bowel lumen, and this contributes to dehydration and electrolyte disturbances. These should be corrected by intravenous infusion titrated against the laboratory findings. Nasogastric decompression eliminates the gastric contents, thus decreasing the incidence of vomiting and aspiration, and also decreasing abdominal pain caused by distension. During bowel obstruction, aerobic and anaerobic bacterial overgrowth occurs. The first-line treatment is a combination of clindamycin and cefazolin (US FDA category B), which should be started once the diagnosis is confirmed.

Surgery is indicated when: (1) medical therapy fails, (2) clinical, laboratory, or radiographic findings of disease progression; and (3) complete obstruction initially. A midline vertical incision is always used, except when an incarcerated hernia is the cause and the incision is made over the incarcerated hernia. The type of midline incision is made according to the estimated site; a medial midline incision for small bowel obstruction, and a lower midline incision for large bowel obstruction. Laparoscopic procedures are rarely performed. Laparoscopic cecopexy (anchoring the cecum to the lateral abdominal wall) can be made in a pregnant patient without a history of previous abdominal operations that could potentially cause adhesions.

27.3.5   Prognosis

The fetal mortality is 20–26 %, and the maternal mortality is 6–20 % [29].

27.4   Acute Pancreatitis

Acute pancreatitis occurs in 1/1000–3000 pregnancies [30], most commonly late in the third trimester and early postpartum. Pregnancy itself could be the cause due to increased intra-abdominal pressure on the biliary and pancreatic ducts. Other causes are: cholelithiasis (the most common cause – in at least 2/3 of patients) [30], alcohol abuse – the second most common cause [30], previous abdominal surgery, blunt abdominal trauma, infections (viral, bacterial, or parasitic), penetrating duodenal ulcer, connective tissue diseases, hyperparathyroidism, and hyperlipidemic pancreatitis [31].

27.4.1   History and Examination

Typical symptoms are the same as in nonpregnant patients. Patients may have a history of previous episodes of upper abdominal pain. There is severe epigastric pain radiating to the back, nausea and vomiting, and fever.

On examination, your patient may be lying in the fetal position with flexed knees, hips, and trunk. Bowel sounds are usually hypoactive, secondary to paralytic ileus. There is diffuse abdominal tenderness. There may also be Grey Turner's sign (bruising of the flanks) and Cullen's sign (bruising around the umbilicus).

27.4.2   Investigations

Leukocytosis is not diagnostic because it is raised in the second and third trimesters and can reach 20×10^9/l in early labor in normal pregnancy. A CRP of 120 mg/l indicates necrotizing pancreatitis. Neutrophil granulocytosis with left shift is present. Serum levels of amylase and lipase may be raised; raised lipase

levels are a better predictor of acute pancreatitis. Serial mea-
surements on a daily basis reveal the progression/regression of
the pancreatic inflammation. The amylase-creatinine clearance
ratio is diagnostic [32]. It is low in normal pregnancy, but has a
value of 5 % or more in pregnant women. Urea and electrolytes
reveal acute prerenal insufficiency and electrolyte imbalance.
Serum glucose confirms hyperglycemia or glucose intolerance.
Hemoglobin and hematocrit levels confirm hemorrhage.

The American College of Obstetricians and Gynecologists
have published the statement: "Women should be counselled
that X-ray exposure from a single diagnostic procedure does not
result in harmful fetal effects. Specifically, exposure to less than
5 rad (50 mGy) has not been associated with an increase in fetal
anomalies or pregnancy loss" [33]. Plain X-ray will help to
exclude other causes of acute abdomen (such as obstruction or
pneumoperitoneum). Also, a sentinel loop may be present (an
air-liquid level at the level of the jejunum) in the upper left
abdomen, which suggests pancreatitis.

Transabdominal ultrasound confirms pancreatitis when there is
(1) an edematous, enlarged pancreas, (2) pancreatic pseudocysts,
(3) free intra-abdominal fluid and/or fluid in the omental bursa,
and (4) thrombosis of the splenic vein due to compression.

CT with IV contrast may be used in complicated patients.
There are no guidelines available that could help to minimize its
use and the radiation exposure. Multidetector row CT with high-
speed mode has half the radiation dose of the high-quality mode
for otherwise identical scanning parameters.

27.4.3   Management

Initially, patients should be treated in intensive care. Vomiting
and third space losses should be corrected by intravenous
infusions. The replacement volume could be up to 10 l in total,
depending on the severity of the pancreatitis and the laboratory
findings. Current recommendations for nasogastric tube decom-

pression are that it should be used only in patients with ileus or nausea and/or vomiting [34]. Pethidine (meperidine) or tramadol and not morphine should be used because these do not produce spasms of the sphincter of Oddi, which could exacerbate the pancreatitis [35]. Prophylactic antibiotics use is controversial, even in severe pancreatitis. Current recommendations for prophylactic use are [36, 37]: (1) severe acute pancreatitis (a CRP >120 mg/l), (2) pancreatic necrosis demonstrated by CT, and (3) persistent fever or signs of sepsis. Imipenem is the antibiotic of choice in patients who are not pregnant, but it is US FDA class C (animal studies have shown an adverse effect, but there are no adequate and well-controlled studies in pregnant women, or no animal studies have been conducted). So, as in acute cholecystitis, combination of antibiotics (e.g., clindamycin and cefazolin) is used.

Surgery is indicated in: (1) infected pancreatic necrosis, (2) a ruptured or infected pancreatic pseudocyst, and (3) severe hemorrhagic pancreatitis causing sepsis or hemodynamic instability. A right subcostal incision (it can be extended over the left hypochondrium) or extended upper midline laparotomy are used. The type of operation depends on the intra-abdominal findings. In necrotizing hemorrhagic pancreatitis, necrosectomy and drainage are performed. For an infected or ruptured pancreatic pseudocyst, open drainage is preferred. When biliary pancreatitis is proven, laparoscopic cholecystectomy with pre- or postoperative ERCP with endoscopic sphincterotomy is performed because of relapse rate up to 70 % [38].

Therapeutic delivery is the procedure performed primarily to cure refractory acute pancreatitis of any cause, especially hyperlipidemic before fetal complications (distress) ensue.

27.4.4   Prognosis

The maternal mortality rate ranges 0–37 %, while the perinatal mortality rate is 11 % [30].

27.5 Spontaneous Hepatic Rupture/Hepatic Subcapsular Hematoma

Spontaneous hepatic rupture and hepatic subcapsular hematoma occur mostly in the third trimester. They can either be a consequence of pregnancy or they can occur simultaneously with pregnancy. Pregnancy-related causes are: (1) intrahepatic cholestasis of pregnancy (progesterone-induced smooth muscle relaxation with biliary stasis), (2) acute fatty liver of pregnancy (moderate elevation of liver enzymes, significant coagulopathy, hypofibrinogenemia, hypoglycemia, and hyperbilirubinemia), and (3) HELLP (hemolysis, elevated liver enzymes, and low platelet levels) syndrome. Causes that occur simultaneously with pregnancy, but are not related are: (1) hepatic hemangiomas, and (2) hepatic tumors (benign or malignant).

27.5.1 History and Examination

There may be a history of pregnancy-induced hypertension with symptoms and signs: (1) related to pre-eclampsia: hypertension, swelling or edema, proteinuria, sudden weight gain, headache, changes in vision, racing pulse, mental confusion, difficulty breathing, and hyperreflexia; (2) nausea and vomiting; (3) abdominal pain in the right hypochondrium or epigastrium; (4) jaundice; and (5) collapse – late in the course of the disease, indicating hemorrhagic shock.

On examination there is: (1) a distended abdomen, (2) abdominal tenderness in the right hypochondrium, and (3) hemorrhagic shock (hypovolemic shock resulting from acute hemorrhage is characterized by hypotension, tachycardia, tachypnea, pale, cold, and clammy skin, and oliguria).

27.5.2   Investigations

Serial measurement of hemoglobin and hematocrit every 6–12 h if nonoperative management is indicated predicts rupture of the subcapsular hematoma. In the presence of adequate iron stores and iron intake, a pregnant patient's hematocrit level often falls below the normal range and is called "physiologic anemia of pregnancy." Hematocrit values of less than 30 % are unusual. Leukocytosis is not diagnostic as it can be up to $20 \times 10^9/l$ at labor in normal pregnancy. Rising values indicate possible infection of the hematoma. Additional laboratory tests for known or unknown pregnancy-related diseases or the diseases that could complicate the course of this condition: serum liver transaminase and alkaline phosphatase levels; serum bilirubin and amylase; coagulation profile and platelet count; serum glucose. During normal pregnancy there is an increase in renal blood flow by about 60 %, leading to an increase in the glomerular filtration rate. This has the effect of reducing serum blood urea nitrogen (BUN) and creatinine by half. Therefore, a relatively "normal" BUN and creatinine may reflect a seriously compromised renal function.

Plain abdominal X-ray eliminates other causes of acute abdomen (e.g., obstruction or pneumoperitoneum).

Abdominal ultrasound delineates a subcapsular hematoma or free intra-abdominal fluid and serial assessment every 6–12 h to define progression or rupture.

Abdominal CT is indicated in a stable patient with an uncertain diagnosis.

27.5.3   Management

Medical management is started as soon as the diagnosis of subcapsular liver hematoma or rupture without shock is established.

Treatment includes: (1) bed rest, (2) treatment of eclampsia, (3) fetal monitoring, (4) correction of coagulopathy, and (5) planned Cesarean section depending on the gestational age. If the fetus is around 20 weeks, then several weeks of observation (to enable fetal viability) is indicated if there are no indications for semi-elective or emergent operation. The right and left hepatic arteries, or both, can be occluded selectively by interventional radiological techniques.

Emergency surgery is indicated in hemorrhagic shock and includes: (1) resuscitation, (2) urgent total median laparotomy, (3) liver packing and transportation to specialized hepatobiliary centers, (4) hepatic resection, and (5) Cesarean section. Semi-elective surgery is indicated if ultrasound or CT progression of subcapsular hematoma is found. The bleeding with liver packing should be performed first. Local measures such as topical hemostatic agents and suture ligation of surface bleeders are of limited value especially when dealing with hemorrhage from large areas of denuded and friable liver in patients with associated clotting deficiencies. Then Cesarean section is made to save the baby and enable more space for definitive liver surgery if indicated.

27.5.4 Prognosis

Perioperative and postoperative mortality rates are 40–60 % for both mother and fetus [39].

27.6 Blunt or Penetrating Abdominal Trauma

27.6.1 Incidence

Trauma affects 6–7 % of pregnancies in the United States [40]. Most commonly it is blunt trauma such as motor vehicle acci-

dents, physical violence (affecting 10 % of pregnant women), or accidental falls [41]. Less common penetrating trauma includes gunshot or stab wounds.

27.6.2 History and Examination

A history is usually easy, except when the injured patient is unconscious, in which case others should be consulted – friends, family, or passersby. The symptoms will depend on injured intra-abdominal organ: (1) placental abruption – vaginal bleeding (78 % of patients), uterine tenderness and back pain (66 % of patients), and uterine contractions (22 % of patients); (2) liver injury – right upper quadrant pain; (3) splenic injury – left upper quadrant pain; (4) perforation of hollow organs – diffuse abdominal pain; and (5) collapse occurs late in the course of the disease due to hemorrhagic shock.

Patient's blood pressure and heart rate are essential. The frequency of these measurements depends on the clinical condition of the patient. Find injury marks on the abdominal wall, such as seat belt marks, entrance and/or exit wounds, and contusions and/or hematomas. There will also be a distended abdomen, abdominal tenderness, or signs of hemorrhagic shock. Uterine contractions, uterine tenderness, or vaginal bleeding suggest severe direct fetal trauma.

27.6.3 Investigations

Hematocrit values less than 30 % are unusual. Serial measurement of hemoglobin and hematocrit every 6–12 h if abdominal pain persists without sonographic evidence of intra-abdominal hemorrhage is performed. Arterial blood pH and serum bicarbonate are important indicators of adequate tissue perfusion and oxygen supply, and a good predictor of fetal death. Additional

laboratory tests for known or unknown pregnancy-related diseases or the diseases that could complicate the course of pregnant patients with trauma are measured: liver transaminases, alkaline phosphatase, bilirubin, and serum amylase; coagulation profile and platelet count; serum glucose. Positive Kleihauer-Betke test means direct blood contact between an Rh- mother and an Rh+ fetus. It determines the required dose of Rho (D) immune globulin to inhibit the formation of Rh antibodies in the mother and prevent Rh disease in future Rh+ children. Between 10 and 30 % of pregnant trauma victims have some evidence of fetal-maternal admixture of blood [42, 43].

X-ray examination is indicated for significant trauma, such as deformities, severe pain, or breathlessness in chest trauma. For nonsignificant trauma, X-ray examination could be delayed, unless there are persisting symptoms. For sprains and some nondisplaced fractures, immobilization is used initially and, in these more minor conditions, X-rays can be taken after 7 days if the pain or dysfunction persists.

Abdominal ultrasound may reveal a subcapsular hematoma of the liver or spleen, or free intra-abdominal fluid.

Fetal cardiotocography is significantly better for the diagnosis of placental abruption than ultrasound [44]. It is mandatory for the evaluation of a possible placental abruption, establishment of gestational age, assessment of amniotic fluid volume, and fetal well-being [42]. Significant fetal mortality may result even from minor trauma [45]. Monitoring of fetal heart rate should be initiated as soon as practicable in sufficiently advanced pregnancies (>20–24 weeks). The presence of contractions greater than one every 10 min indicates a 20 % risk of placental abruption [46]. For minor trauma, fetal monitoring is needed for 4–6 h. For major trauma with frequent uterine contractions, an abnormal fetal heart rate pattern, vaginal bleeding, or uterine tenderness, fetal monitoring is needed for a minimum of 24 h.

27.6.4   *Management*

Medical management includes [44]: (1) stabilization of the mother using supplementary oxygen, intravenous fluids (blood transfusion if indicated), (2) placing the mother in the left lateral position after 24 weeks gestation, and (3) the American College of Obstetricians and Gynecologists recommends giving D-immunoglobulin to all sensitized Rh- pregnant patients [47].

Surgery in hemorrhagic shock includes: (1) resuscitation, (2) urgent total median laparotomy, (3) liver packing and transportation to specialized hepatobiliary centers, (3) hepatic resection in a specialized center, (4) splenectomy in splenic rupture, (5) Cesarean section – if the gestation is over 24–28 weeks even during unsuccessful maternal resuscitation, when it should be performed within 5 min. *Damage control surgery* is rapid termination of an operation after control of life-threatening bleeding and intestinal spillage (systolic blood pressure <90 mmHg; T <34°C; activated partial prothrombin time >60 s; pH <7.2 or arterial base deficit ≥8; major intra-abdominal vascular injury; associated need for management of extra-abdominal life-threatening injury), followed by correction of physiological abnormalities, which precedes definitive management of initial injuries. In non-life-threatening conditions, standard procedures should be used as indicated: suturing of small and large bowel ruptures before peritonitis develops, bowel segment resections or stoma creation when peritonitis is present.

27.6.5   *Prognosis*

Trauma is the leading cause of nonobstetric maternal death [40].

Fetal injury in maternal penetrating trauma is high from both stab (42 %) and gunshot wounds (71 %) [48, 49]. The rate

of fetal mortality after blunt maternal trauma is 3.4–38 % [40, 50], and is mostly a result of placental abruption, maternal shock, and maternal death. There are no strong clinical predictors of fetal death [51, 52]. A high injury severity score, low levels of hemoglobin, the need for a blood transfusion, and the presence of disseminated intravascular coagulation caused by an admixture of maternal and fetal blood are the most significant predictors of fetal mortality [53]. Even minor trauma can cause fetal death. Fetal outcome is highly dependent on gestational age and less so on the injury type, mechanism, or the severity of the injury. Women under 28 weeks' gestation have the highest risk of fetal, neonatal, or infant death [52]. Perimortem Cesarean section has a fetal survival rate of 50–70 % [54].

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