


Surgical causes of acute abdominal pain in pregnancy

Natalie Woodhead MBChB MRCOG,^{a,*}  Oga Nkwam MBBS BSc,^b Virginia Caddick MBChB MA (Cantab) MRCS,^c Sharon Morad MBChB,^d Senthurun Mylvaganam BSc (Hons) MBBS MA MFST FRCS^e

^aSpecialty Trainee in Obstetrics and Gynaecology (Year 6), University Hospital, Coventry, CV2 2DX, UK

^bSpecialty Trainee in Obstetrics and Gynaecology (Year 2), Birmingham Women's Hospital, Birmingham, B15 2TT, UK

^cCT2 General Surgery, New Cross Hospital, Wolverhampton, West Midlands WV10 0QP, UK

^dConsultant Obstetrician, Heartlands Hospital, Bordesley Green East, Birmingham B9 5SS, UK

^eConsultant Breast and General Surgeon, New Cross Hospital, Wolverhampton WV10 0QP, UK

*Correspondence: Natalie Woodhead. Email: nwoodhead@doctors.org.uk

Accepted on 12 June 2018.

Key content

- Abdominal pain in pregnancy is common, with a differential diagnosis that can encompass obstetric, surgical and medical conditions.
- Presentation of common surgical problems can be atypical in pregnancy, potentially delaying diagnosis.
- Surgical causes of abdominal pain to consider in pregnancy include appendicitis, cholecystitis, bowel obstruction, ureteric obstruction, pancreatitis and aneurysm rupture, most commonly involving the splenic artery.
- The management of surgical conditions in pregnancy requires continuing evaluation and potential modification to balance the medical, surgical and obstetric challenges.
- Management of the pregnant woman with a surgical cause of abdominal pain requires collaborative, multispecialty practice to optimise care of the mother and baby.

Learning objectives

- To highlight the differential diagnoses of abdominal pain in pregnancy.
- To develop a structured assessment process for pregnant women with abdominal pain.
- To update the obstetrician on the priorities of surgical management for abdominal pain in pregnancy.

Ethical issues

- Evaluating the risks of surgical interventions on the mother and baby with the high potential for premature delivery.

Keywords: aneurysm rupture / appendicitis / bowel obstruction / cholecystitis / pancreatitis

Please cite this paper as: Woodhead N, Nkwam O, Caddick V, Morad S, Mylvaganam S. Surgical causes of acute abdominal pain in pregnancy. *The Obstetrician & Gynaecologist* 2019;21:27–35. <https://doi.org/10.1111/tog.12536>

Introduction

Abdominal pain and gastrointestinal symptoms are relatively common complaints of pregnancy. Diagnosis of the acute abdomen in pregnancy remains one of the most challenging diagnostic and therapeutic dilemmas. The incidence of acute abdomen during pregnancy is 1 in 500–635 pregnancies.¹ Women may be more anxious about abdominal pain experienced in pregnancy because of concerns over the significance and risk to the baby. Specialists in obstetrics and gynaecology may be quick to attribute symptoms to obstetric complaints and fail to recognise other important differentials. A structured approach is required to assess patients with abdominal pain in pregnancy that both considers and has the ability to exclude the full range of potential differential diagnoses. Surgical conditions may be uncommon, but clinicians need to be alert to them as they can present differently in pregnancy. Consideration of these conditions, allowing for

either early diagnosis or exclusion, is important to optimise outcome for both mother and baby.

Abdominal pain in pregnancy requires thorough evaluation. Although the cause is frequently found to be nonsignificant, serious life-threatening pathology can occur and can present both insidiously and atypically. Table 1 lists the differential diagnoses to consider. When dealing with surgical complications in pregnancy, early senior surgeon input should be sought and achieved and should not be delayed by team hierarchy.² Approximately three maternal deaths per year in the UK are attributed to intra-abdominal pathology. Information on intrauterine deaths from maternal disease/peritonitis is not systematically collected, so this aspect of mortality is unmeasured, but is likely to be higher.³ Table 2 details the mortality associated with non-obstetric causes of abdominal pain,^{3,4} and Box 1 details the red flags that should prompt senior clinician evaluation.

This review presents the principles of a structured assessment and investigation of the pregnant woman with

abdominal pain and the differential diagnoses to consider. The operative management of the pregnant woman with specific surgical conditions in pregnancy is outside the remit of this article and needs to be tailored to each individual.

Structured assessment algorithm

History

History taking remains an essential clinical skill.⁵ The goals include:

1. **Evaluating the presenting symptom** to refine the differential diagnosis.

Table 1. Differential diagnoses of abdominal pain in pregnancy

Obstetric causes	Non-obstetric causes
Early pregnancy	Surgical
Miscarriage	Appendicitis
Ectopic	Biliary colic/cholecystitis
Acute retention of urine associated with retroversion of the uterus	Pancreatitis
Fibroids	Peptic ulcer disease
Round ligament pain	Bowel obstruction
	Ureteric obstruction
	Aneurysm rupture
Late pregnancy	Nonsurgical
Abruption	Pyelonephritis
Labour (and preterm labour)	Inflammatory bowel disease
Uterine rupture	Ovarian cyst accidents (torsion, haemorrhage, rupture)
Acute fatty liver of pregnancy	Constipation
Pre-eclampsia/haemolysis, elevated liver enzymes, low platelets (HELLP) syndrome	Trauma, domestic violence, assault
Chorioamnionitis	Psychogenic
Symphysis pubic dysfunction	Pneumonia
Fibroid degeneration (early/late or both)	Other rare medical
Braxton-Hicks contractions	a) Myocardial infarction
	b) Diabetic ketoacidosis (DKA)
	c) Porphyria

2. **Assessing the past obstetric, medical, surgical and family history** to identify any risk factors that predispose to certain conditions, such as Marfan's syndrome and aneurysms, or that may modulate the natural history of certain conditions.
3. **Do not forget to enquire about trauma**, including domestic violence (during partner absence). Pregnancy represents a period of higher risk for domestic abuse.⁶ Other causes of trauma include road traffic accidents and falls.

The history of abdominal pain should include:

1. Site, including radiation of pain to other sites;
2. Quality, duration and timing of the pain;
3. Exacerbating and relieving factors;
4. Associated symptoms.

Site and radiation of pain

Ask the woman to indicate the site of pain. If it is **focal** (she can point to the origin of the pain with one finger) and sharp, this is more suggestive of **peritoneal pain**. A **visceral pain** history is often described as segmentalised or **poorly localised**. It is clinically useful to differentiate a history of peritoneal or visceral abdominal pain. This can indicate the underlying aetiology, though be aware that in various disease processes – depending on timing of presentation – a visceral, peritoneal or mixed

Box 1. Clinical red flags (require senior clinician evaluation)

1. Readmission or multiple admissions
2. Repeated doses of opiates given for analgesia without a cause for pain being established
3. New-onset anxiety and confusion being attributed to a psychiatric cause rather than underlying (undiagnosed) organic disease

Table 2. UK deaths caused by non-obstetric abdominal pathology in pregnancy (adapted from Brown and Howell,³ with additional data indicated by * from Knight et al.⁴)

Cause of death	1997/99	2000/02	2003/05	2006/08	2009/12	2013/17*
Splenic artery aneurysm	1	0	0	0	3	9
Other aneurysm: iliac, coeliac artery					3	1
Liver failure	1	0	3	4	2	1
Pancreatitis	2	1+1	2+2	0	-	2 late deaths
Intestinal obstruction	3	3 (+1 late death)	0	0	-	-
Peritonitis (including from appendicitis)	0	1	2	0	3	-
Crohn's disease	0	0	0	2	-	-
Duodenal ulceration	0	0	0	2	-	-
Liver rupture	1	0	1	0	-	-
Pseudo-membranous colitis	0	0	0	1	-	-
Ruptured oesophagus	0	1	0	0	-	-

history may be given. As suggested, visceral pain originates from injury to a hollow viscus (tube-like structure). Pain related to **foregut visceral** structures (mouth to proximal duodenum, including gall bladder) is generally felt in the **upper abdomen**, while that associated with **midgut structures** (distal duodenum to mid-transverse colon) is felt around the **umbilicus**. **Hindgut structure** (remaining colon and rectum) pain is generally felt in the **lower abdomen**. Shoulder-tip pain is associated with diaphragmatic irritation; for example, with haemoperitoneum or following visceral content leakage from perforation.

Quality of pain

Colicky pain occurs as a consequence of the **partial or complete obstruction of a hollow viscus**, for example, the ureter, biliary duct or bowel. The history is often of waves of pain coming and going, or increasing and decreasing in intensity. **Burning pain** that **radiates retrosternally** is often indicative of **peptic ulcer or oesophagogastric disease**; pancreatitis can also present as retrosternal pain. Constant pain that is focal or generalised indicates peritoneal inflammation: there are multiple causes but all require early initiation of appropriate treatment.

Duration and timing of pain

A **sudden onset of severe pain should raise suspicion**; however, many of the surgical differential diagnoses to consider have an initially more insidious history. Pain may change in site or severity over time. This can provide important clues as to the underlying differential diagnosis and to progression of diagnosed surgical conditions. This underlines the importance of regular patient re-evaluation.

Exacerbating and relieving factors

For different disease processes the pain may be modulated by certain actions. Patients reporting **visceral pain** often describe **restlessness**, while those with **parietal** injury/irritation describe **movement as exacerbating** the pain. This may help to determine the differential diagnosis if reported, but absence in the history may not add to clinical assessment.

Associated symptoms

Eliciting a history of associated symptoms, specifically including their **temporal relationship to the abdominal pain** episode, can be revealing. The surgical differential diagnoses for abdominal pain may present with other gastrointestinal or urinary symptoms, about which the clinician should enquire. As described for the specific surgical conditions listed in Table 3, presence of these in the abdominal pain history may evolve and can aid refinement of the differential diagnosis.

Examination

General

A primary survey following the advanced life support **ABCDE** (airway, breathing, circulation, disability and exposure) approach should be undertaken.⁷ The detail of this survey will be refined depending upon the diagnosis of acute respiratory, metabolic or haemodynamic compromise. **Pregnancy-specific physiological changes should be understood** during the assessment. Abdominal examination should follow the principles of inspection, four-quadrant palpation, percussion, auscultation and digital rectal examination.

Pregnancy-specific considerations

Physiological changes

Total blood volume increases by approximately 40% above nonpregnant levels. **Cardiac output increases because of a 10–30%** rise in stroke volume and a **rise in resting heart rate** from the normal 70 bpm to 80–90 bpm. Changes to the respiratory system are less marked; however, **metabolic rate increases**, leading to an increase in oxygen consumption of 20%, with a slight **rise in basal body temperature** as a byproduct. To meet the increased oxygen requirement, **ventilation increases by 40%** (physiological hyperventilation), but there is no change in the vital capacity or the respiratory rate; **pregnant women breathe more deeply, increasing their tidal volume from 500 to 700 ml**, thus increasing respiratory capacity.⁸

These physiological changes in pregnancy mean there is often **poor correlation between clinical signs associated with blood loss and the degree of hypovolaemia** because pregnant women are **known to compensate for a relatively long time before becoming symptomatic of blood loss**.⁹ Mild tachycardia, tachypnoea, narrowed pulse pressure and agitation are the earliest signs of hypovolemic shock. Fall in blood pressure is a late sign. Assessment must consider fetal wellbeing, as well as maternal wellbeing, by either fetal heart auscultation or cardiotocography depending on gestation; fetal compromise demonstrated by either modality may suggest serious maternal pathology and a need for maternal resuscitation.

Anatomical considerations

The gravid uterus can hamper the clinical assessment; it can make **free fluid in the peritoneal cavity or haemoperitoneum more difficult to identify**. It can also make it more **difficult to palpate abdominal masses/pathology** and **change the position of abdominal organs; for example, the appendix**, which moves up with the gravid uterus such that pain can be described in the right

Table 3. Clinical presentations of the surgical causes of acute abdominal pain in pregnancy

Condition	Clinical presentation
Ruptured/leaking abdominal aneurysm	<ul style="list-style-type: none"> History can vary depending on site, nature and rate of blood loss. The most acute rupture can present as an unexplained collapse that may be preceded by severe acute abdominal or back pain, typically interscapular pain. Pain may also radiate from the abdomen to the back or groin. Be wary of urinary tract symptoms including dysuria and microscopic haematuria in a patient with an aneurysm history or risk factor for aneurysm such as Marfan's syndrome.
Appendicitis	<ul style="list-style-type: none"> Acute or gradual onset colicky periumbilical pain that then localises to the right iliac fossa. A retrocaecal or pelvic positioned appendix may present atypically with either primarily urinary symptoms or pelvic pain. The gravid uterus can also displace the appendix so pain may be described in the right upper quadrant. The presentation may progress with appendiceal perforation to more generalised peritonitis. There is frequent association with nausea, vomiting and anorexia.
Biliary colic and acute cholecystitis	<ul style="list-style-type: none"> Acute or gradual onset right upper quadrant or epigastric pain often worsened by eating. Although termed 'colic' is often constant but remits after a period of minutes to hours. This may radiate to the back or flank. Focal tenderness is more prominent with progression from biliary colic to cholecystitis. Clinically eliciting Murphy's sign (tenderness increased on inspiration while palpating in the right upper quadrant) is highly suggestive of the diagnosis.
Bowel obstruction	<ul style="list-style-type: none"> May present with any combination of colicky abdominal pain, nausea and vomiting, abdominal distension and constipation or absolute constipation (inability to pass flatus). The history can vary depending on the completeness and site of obstruction. Small-bowel obstruction commonly initially presents with nausea and vomiting (bilious, depending on site of obstruction) and colicky abdominal pain. Large-bowel obstruction commonly initially presents with abdominal distension, absolute constipation and colicky abdominal pain. Vomiting, which may be faeculent, is a late feature of large-bowel obstruction. Clinical examination may elicit high-pitched or absent bowel sounds.
Pancreatitis	<ul style="list-style-type: none"> It is important to consider that this may present following episodes of biliary colic or cholecystitis. In addition, the history may initially be similar to that of biliary colic or cholecystitis. Sudden onset of severe upper abdominal pain that may be eased by leaning forward is typical. Examination may elicit upper abdominal tenderness and, depending on severity and progression of the disease, haemodynamic shock may ensue.
Peptic ulcer disease	<ul style="list-style-type: none"> Gradual or acute onset of retrosternal or upper abdominal pain is commonly reported. The relationship of this with eating differs depending on whether this is gastric or duodenal disease (gastric disease worsens with eating while duodenal disease improves with eating). The major complications include bleeding or perforation. Clinical examination may not reveal any abdominal signs. It is important to be aware that following perforation, depending on whether this is into the retroperitoneal or peritoneal space, will determine whether the clinical features of peritonitis can be observed.
Urinary tract obstruction	<ul style="list-style-type: none"> May be caused by obstruction within the lumen, within the wall of the urinary tract or external compression. Obstruction can be caused by ureteric calculi, although the gravid uterus must also be considered, particularly in the second and third trimesters. Typically presents with colicky pain, often radiating from loin to groin. The patient may report associated nausea and vomiting; macroscopic haematuria may be seen on urinalysis.

upper quadrant. Laying the woman on her side to displace the uterus may help to differentiate uterine from extra-uterine tenderness; if the site of maximum tenderness remains constant when the uterus moves, the pain may be more likely to be extra-uterine in origin. Rising levels of obesity seen in the obstetric population only add further to the diagnostic challenge.

Table 3 provides a summary of the key presentations and clinical symptoms and signs of each of the surgical conditions causing acute abdominal pain in pregnancy.

Investigations

Following a complete history and examination, investigations should be performed that aid the diagnostic process, provide information on the severity of the condition or response to treatment, or inform prognosis.

Bedside

Routine observations (pulse, blood pressure, temperature, respiratory rate and oxygen saturation tests) should be

performed along with a urine dipstick at the bedside. Mild glycosuria and/or proteinuria can occur in normal pregnancy because the increased glomerular filtration rate can overwhelm the ability of the renal tubules to reabsorb. When an automated reagent strip-reading device is used to estimate proteinuria, a result of 1+ or more should lead to consideration of hypertensive diseases of pregnancy and a protein quantification test should be performed. Significant proteinuria is diagnosed if the urinary protein:creatinine ratio is greater than 30 mg/mmol, or if a validated 24-hour urine collection result shows greater than 300 mg protein.¹⁰ Increasing amounts of proteinuria may indicate renal disease. The presence of leucocytes and nitrites are indicative of urine infection and a midstream urine specimen should be sent.

Although acute myocardial infarction (MI) in women of childbearing age is rare (6.2 per 100 000 deliveries), pregnancy increases the risk by three to four times.¹¹ The risk is further increased with advanced maternal age, particularly those over the age of 40 years. Acute MI can present as acute upper abdominal pain, or even symptoms suggestive of gastro-oesophageal reflux disease (GORD), therefore an electrocardiogram (ECG) should be considered.

Biochemical

A full blood count, liver function tests and tests to determine urea, electrolytes, amylase and C-reactive protein (CRP) levels can provide useful information in the assessment and differential diagnosis of surgical conditions. It is important to understand that interpretation should be adjusted according to pregnancy-related physiological changes and considered within the overall patient assessment. In pregnancy there is a disproportionate rise in plasma volume compared with red cell mass, resulting in haemodilution and decreased haemoglobin and haematocrit count (physiological anaemia).⁸ A moderate rise in leucocyte count is normal in pregnancy (normal values $5.9\text{--}15.6 \times 10^9/l$). CRP is a useful marker of underlying infection and inflammation. In pregnancy, the upper limit of normal is suggested as 20 mg/l; a rise in CRP levels is considered more reliable as a marker of infection than a one-off raised value.¹² Renal blood flow and glomerular filtration rate (GFR) both increase in pregnancy, leading to increased creatinine clearance and lower serum creatinine levels. 'Normal' creatinine levels in pregnancy may indicate impairment. The timing of the test within the disease process and trend of certain parameters may also require consideration. Arterial blood gas (ABG) samples may also have a role in the assessment of certain surgical conditions, but this should prompt discussion with a senior surgeon/anaesthetist. The physiological hyperventilation of pregnancy results in a higher pO_2 level and a lower pCO_2 , with a compensatory fall in bicarbonate on ABG analysis compared with a nonpregnant patient. Lactate is a

byproduct of anaerobic respiration, and therefore raised lactate (>1.0 mmol/l) is useful as a marker of poor tissue perfusion. Lactate is also used in the recognition of sepsis and response to treatment: a level >4 mmol/l is a marker of severe sepsis and indicates the need for goal-directed sepsis therapy.¹³

Imaging

The use of imaging tools such as ultrasound, computed tomography (CT) and magnetic resonance imaging (MRI) can aid the assessment and management of patients with a possible surgical cause of abdominal pain. Requesting imaging should not delay treatment in the unstable patient. The decision to obtain imaging and its timing should be made in consultation with a senior surgeon and balance the risk and benefit to the mother and child. Imaging findings require interpretation and clinical correlation so should be done in collaboration with a surgeon, radiologist and obstetrician.

Plain film chest X-ray

An erect chest X-ray with abdominal shielding can be considered safe. The estimated fetal dose of radiation per examination is $2\text{--}7/10^4$ milligray (mGy). A dose of up to 10 mGy has negligible risk to the developing pregnancy in any trimester and carries an increase in childhood cancer risk of 0.002%.¹⁴ The presence of air under the diaphragm suggests perforation of a viscus, with high sensitivity but low specificity. If abdominal signs of peritonitis are present, more sensitive imaging such as MRI will be considered to make a definitive diagnosis.

Ultrasound

Transabdominal ultrasound is used to assess the viability of the pregnancy, location of the placenta and to visualise fibroids or ovarian pathology. The liver, gallbladder, bile ducts and renal tract can also be demonstrated. In pregnant patients with right iliac fossa pain, the appendix can be visualised using ultrasound in up to 60% of cases; however, an inconclusive scan result is seen in up to 90% of cases.¹⁵ Another study suggests that ultrasound has a 100% specificity rate in the diagnosis of acute appendicitis and is therefore a valuable first-line imaging modality, especially in centres where MRI may not be readily available.¹⁶

Magnetic resonance imaging and computerised tomography

MRI is preferred because there is no associated risk of ionising radiation to the mother or fetus and it has been shown to demonstrate equivalent accuracy in the diagnosis of nontraumatic pathology compared to ultrasound and CT.¹⁷ However, the ability to organise an MRI scan, especially out of hours, as well as the availability of a skilled radiologist to interpret the scan, may not be possible at some hospitals.

CT is the most sensitive and specific modality for the investigation of abdominal pain but, in doing so, the fetus and mother are both exposed to a dose of radiation, which must be discussed. The dose of radiation exposed to the fetus during a CT scan of the abdomen and pelvis may be as high as 30–50 mGy.¹⁸ The fetus is most susceptible to the teratogenic effects of ionising radiation during the period of organogenesis (between 5 and 15 weeks of gestation).¹⁹ Even at these doses of radiation exposure, the risk to the fetus is small, but the risk of childhood cancer is increased by 0.1% and fatal adult cancers by 0.3%.¹⁴

Management

After the initial assessment of patients with acute abdominal pain, resuscitation will be instituted as needed, and pain relief provided; nonsteroidal anti-inflammatory drugs should be avoided. The assessment of whether any further diagnostic tests are needed will then be discussed. The surgeon will aim to refine the differential diagnosis but – as importantly – will also define the clinical parameters upon which a decision is made about early operative intervention versus a period of close observation.

Anaesthetic and medical considerations

For all acutely unwell patients, or where surgery is considered, optimisation of medical comorbidities can improve outcomes.²⁰ Clinical assessment will determine pre-existing or pregnancy-induced comorbidities that must be addressed. Multispecialty input may be invaluable and should be sought early. Early involvement of senior anaesthetists, ideally with experience of obstetrics, is vital if operative management is being considered, to allow them to assess, plan and guide patient optimisation prior to theatre.

Obstetric considerations

The obstetrician is best placed to oversee and coordinate multidisciplinary care; usually the delivery suite high-dependency unit is the most appropriate location for women in the third trimester. If operative intervention is needed, women should be informed that although surgery is associated with a small increased risk in miscarriage (0.7%) and preterm labour (3.2%),²¹ this increase is often associated with the underlying pathology and delaying a necessary operation may be associated with worse outcome for mother and fetus. The limited evidence available seems to suggest that laparoscopy is associated with an increased rate of miscarriage versus laparotomy, with a comparable rate of preterm birth.²² Prior to surgery, patients must be fully informed of the risk and benefits of the procedure they are about to undergo. This should include the advantages and disadvantages of the available surgical approaches to herself and the unborn child. Any woman undergoing surgery after

20 weeks of gestation should be positioned with a left lateral tilt to minimise compression of the inferior vena cava.²³ Between 24 and 34⁺6 weeks of gestation, preoperative steroids should be given to promote fetal lung maturity (where the clinical situation permits) because preterm labour is a risk. Fetal monitoring (auscultation of the fetal heart in the second trimester and cardiotocography in the third trimester) should be carried out before and after the procedure. As long as maternal oxygenation and uteroplacental perfusion are maintained, the fetus should tolerate surgery well. It is rarely necessary to deliver the fetus to treat the mother; however, late in the third trimester consideration may be given to delivering prior to surgical intervention. In cases where the patient is critically ill – e.g. a perforated appendix – delivery of the baby increases the effectiveness of maternal resuscitation and improves recovery time.²⁴ Postoperative venous thromboembolism prophylaxis must not be forgotten. If there has been any manipulation of the uterus during surgery, anti-D serum should be given to Rhesus D-negative women if the fetal blood group is Rhesus D-positive or unknown.

Surgical considerations

Surgical priorities include synchronous assessment and resuscitation of patients following the ABCDE prioritised approach.⁷ The key decision to be made is whether or not the patient requires an operation. If this is considered, a multispecialty approach is needed, with expert assessments required by the surgeon, anaesthetist, obstetrician and potentially other specialties. Agreement will be required on the priorities for the mother and baby to determine what interventions are needed, when they should be undertaken and any continuing supportive treatment that may need to be planned and arranged.

Specific surgical conditions will now be considered, highlighting the priorities in surgical management.

Surgical conditions

Appendicitis

Acute appendicitis is the most common acute surgical cause of abdominal pain in pregnancy, affecting 1 in 800–1500 pregnancies.²⁵ It occurs most commonly in the second trimester. Appendiceal perforation is, however, more common in the last trimester, perhaps owing to the stretched peritoneum.

Urinalysis may reveal leucocytes if the appendiceal inflammation is in contact with the bladder. Biochemical tests may reveal evidence of inflammation. Ultrasound may show a thickened appendix with surrounding fluid that would suggest appendicitis. However, this is operator-dependent, with overall sensitivity of 60–70% and specificity of 83–96%.^{26,27} When there is continuing clinical

uncertainty, and when imaging is thought to still be of value, MRI can be used safely if rapidly accessible; it has a reported sensitivity of 91% and specificity of 98%.²⁸ A diagnostic laparoscopy may be required if there is continued uncertainty in diagnosis or delay in access to MRI.

Appendicitis is a surgical condition requiring surgery. This may be conducted as an open or laparoscopic procedure, dependent on the severity of presentation, surgeon expertise and gestation. The severity of appendicitis dictates the degree of maternal and fetal morbidity.²⁴ Appendicitis is a progressive disease, with early diagnosis and treatment preventing appendiceal perforation and localised or generalised peritonitis caused by purulent or faecal contamination. For chronic appendicitis or appendiceal masses in the nonpregnant patient, conservative management with intravenous antibiotics and fluid resuscitation may be considered. Minimal data are available for this management option in pregnant patients.²⁴

Biliary colic/cholecystitis

Physiological changes in pregnancy (e.g. cholesterol secretion and supersaturation of bile) can predispose to gallstone formation, which in turn predisposes women to biliary colic and cholecystitis.²⁵ Cholecystitis is the second most common abdominal surgical pathology in pregnancy, with 1–6 cases in 1000 pregnancies; over 90% of cases are associated with gallstone disease.²⁵ During the latter stage of pregnancy when the appendix is displaced by the gravid uterus, the clinical history of acute appendicitis and biliary colic progressing to cholecystitis can be very similar.

Biochemical tests may reveal evidence of inflammation. Liver function tests are essential to determine whether there is an obstructive jaundice picture. This may indicate an obstructing common bile duct (CBD) stone warranting further investigation and treatment.

Transabdominal ultrasonography is the initial imaging investigation of choice for biliary colic and cholecystitis, with >95% sensitivity for detecting gallstones. Where liver function tests and ultrasonography suggest that a CBD stone is causing obstruction, the British Society of Gastroenterology recommends proceeding to endoscopic retrograde cholangiopancreatography (ERCP) for confirmation of diagnosis and removal.²⁹

Biliary colic can be managed with adequate analgesia and anti-emetics. Following resolution of the acute episode, definitive laparoscopic cholecystectomy is subsequently required. Initial management of acute cholecystitis involves intravenous fluid resuscitation, analgesia, a nil-by-mouth regimen and intravenous antibiotics. Urgent surgical intervention is only required if the disease progresses with perforation and subsequent focal or generalised peritonitis. Definitive surgery is preferable during the index admission for biliary colic and cholecystitis to reduce the risk of recurrent symptoms and complications. Gallstone disease has

been shown to increase the risk of maternal readmission by 4.7 times, with surgery reducing the risk to just 0.4 times greater than those without gallstone disease during pregnancy.³⁰ However, in practice, local service capacity influences such a pathway.

Bowel obstruction

Bowel obstruction occurs in approximately 1 in 1500 pregnancies.²⁵ The increasing overall incidence is predominantly attributable to adhesional obstruction following previous abdominal surgery.³¹ Bowel displacement and distortion secondary to the gravid uterus may also predispose to twisting of bowel loops causing partial or complete obstruction.²⁵ Colonic pseudo-obstruction, sometimes referred to as Ogilvie's syndrome or functional colonic obstruction, can be a complication of pregnancy and delivery, most commonly by caesarean section.³²

Biochemical tests may be used to diagnose any electrolyte imbalances or renal impairment secondary to hypovolaemic shock caused by third-space losses. Abdominal X-ray is avoided because of the potential harm to the fetus. Ultrasound and MRI are considered safe. Initial treatment is conservative: intravenous fluids, nasogastric tube insertion and a nil-by-mouth regime. This may be refined based on the underlying aetiology with senior surgeon direction. Large- or small-bowel obstruction may be complicated by ischaemia and perforation, with the risk increased depending on underlying aetiology and delay in treatment. Multispecialty cooperation and early senior surgeon consultation is recommended.

Pancreatitis

Pancreatitis is a rare event in pregnant patients, occurring in 3 in 10 000 pregnancies.²⁵ It is most commonly associated with biliary disease, with 70% of cases being a direct result of gallstones passing through or obstructing the biliary tree. Initial treatment includes establishing the diagnosis, determining the severity, resuscitation and disease-specific therapy (such as ERCP for extraction of CBD stones). Specifically, liver function tests may reveal an obstructive pathology caused by gallstones. Serum amylase levels of more than three times the upper limit of normal may be diagnostic; however, pancreatitis may exist with lower levels of amylase because, during a prolonged history, the amylase concentration may have normalised. Serum lipase is more sensitive and specific than amylase for diagnosis of acute pancreatitis.³³ Early senior surgeon input is required if pancreatitis is suspected. Surgical expertise can guide severity stratification and specific therapies. Severe acute pancreatitis is most appropriately managed in a unit with specialist expertise³⁴ because complications may produce multiorgan dysfunction requiring intensive support measures.

Ureteric obstruction and pyelonephritis

Clinicians should enquire as to whether the patient has a history of renal calculi. Complications of ureteric obstruction include hydronephrosis and pyelonephritis. Mild renal hydronephrosis is considered normal in pregnancy up to a pelvicalyceal diameter of 5 mm on the left and 15 mm on the right, and dilatation of the ureters up to 2 cm in the third trimester.⁸ Flank or back pain may be reported, with associated features of sepsis. Urinalysis may show leucocytosis or microscopic haematuria. Biochemical tests may reveal evidence of sepsis or renal impairment. Ultrasound and MRI are considered safe to inform the diagnosis and underlying aetiology. Cases of pyelonephritis in pregnancy should be admitted for intravenous antibiotic and fluid therapy. Surgery may be indicated for those who deteriorate despite treatment, or who are very unwell with abscess, emphysematous pyelonephritis or an obstructing calculus.³⁵ Ureteric obstruction may require decompression. This can be carried out endoscopically (with stenting) or via percutaneous nephrostomy. If ureteric obstruction is considered, early senior urologist consultation is essential to guide initial and continuing management.

Rupture of visceral artery aneurysm

Although rare, the risk of abdominal aneurysm rupture or dissection is significantly increased in pregnancy (incidence rate ratio 4.0; 95% confidence interval [CI] 2.0–8.2).³⁶ The priority of initial management is diagnosis and balanced or minimum resuscitation to achieve permissive hypotension, because volume replacement can increase bleeding out or dislodge the clot. Prompt consultation and assessment by a senior vascular surgeon is required to direct management and to conserve the 'window of opportunity' for successful emergency repair. Open repair is preferable to avoid the radiation exposure associated with endovascular repair. Half of all arterial aneurysm ruptures in women of child-bearing age are associated with pregnancy. Splenic artery aneurysm is the most common type of visceral artery aneurysm, with up to 95% of cases presenting during pregnancy and being associated with high maternal and fetal mortality. Previous maternal death reports featuring small numbers of women with arterial aneurysm rupture have highlighted a possible relationship to undiagnosed connective tissue disease. These events seem largely unpredictable and unavoidable, although with prompt and rigorous action survival is occasionally possible.⁴

Conclusion

In summary, when assessing the pregnant woman with acute abdominal pain, it is essential to consider surgical conditions in the differential diagnosis. A sound understanding of the

principles of a thorough history and examination, with awareness of the specific adaptations and considerations that must be made in pregnancy, is key to the structured assessment. Prompt clinical assessment, escalation and senior decision-making are key to achieving the best outcomes for mother and baby. Management of the pregnant woman with a surgical cause of acute abdominal pain requires collaborative multispecialty practice and planning and should take into account the needs of the mother and the unborn baby.

Disclosure of interests

There are no conflicts of interest.

Contribution to authorship

NW instigated the article, researched the outline draft, wrote sections, coordinated the writing and edited the final version. ON, VC and SMO wrote sections of the article. SMy made critical revisions and edited the article. All authors read and approved the final version of the manuscript.

Supporting Information

Additional supporting information may be found in the online version of this article at <http://wileyonlinelibrary.com/journal/tog>

Infographic S1. Surgical causes of abdominal pain in pregnancy.

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