Abdominal pain in late pregnancy

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Abstract

Abdominal pain in late pregnancy is a common presentation and can pose a diagnostic and management dilemma to clinicians. An acute abdomen affects 1 in 500 pregnancies with approximately 0.5% −2% of pregnant women needing surgical interventions in pregnancy. The majority of acute abdominal complaints will present in a similar manner to the non-pregnant patient, however the anatomical and physiological changes of pregnancy can complicate the diagnosis and management options. Appendicitis remains the most common cause of an acute abdomen in pregnancy. Management should be tailored depending on the patient and the severity of the condition. Special consideration should be made for the fetus but the life of the mother should be of primary concern. Surgery can therefore be performed at any stage of pregnancy if, on balance, it is the most appropriate option. Clinicians should not neglect obstetric causes of pain and endeavour to always diagnose the underlying cause of the abdominal pain to aid management. This article explores the different aetiologies of pain in late pregnancy and latest advances in management.

Keywords abdominal pain; acute abdomen in pregnancy; anaesthetics in pregnancy; appendicitis in pregnancy; pregnancy; radiation in pregnancy; surgery in pregnancy

Introduction

Abdominal pain is a common presentation in pregnancy and may be secondary to the anatomical changes of pregnancy or pathology. An acute abdomen in pregnancy remains a diagnostic and management dilemma. The incidence of an acute abdomen in pregnancy is 1 in 500 pregnancies and so cases may only be see a hand full of times in each obstetric unit every year. 0.5% −2% of pregnant women will require surgery for a non-obstetric acute abdomen in pregnancy. It is imperative that obstetricians give due consideration to non-obstetric causes of pain and approach abdominal pain in a systematic manner to mitigate against misdiagnosis. Differential diagnoses for abdominal pain in pregnancy are given in Table 1.

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Anatomical changes in pregnancy

Outside of pregnancy, the uterus lies within the pelvis. From the 12th week of pregnancy it becomes an intra-abdominal organ. By the 20th week of pregnancy the uterus can be palpated at the level of the umbilicus, and it reaches the costal margin by 36 weeks. Adjacent abdominal viscera can be displaced by the growing uterus (Figure 1). The displacement of the omentum can limit its ability to compartmentalise inflammation, whilst the stretched abdominal wall can mask guarding. The gravid uterus can also make palpating for masses and assessing for fluid in the abdomen more difficult.

Physiological changes in pregnancy

Pregnancy is associated with an increase in liver metabolism. Due to the increase in blood volume the serum concentration of albumin is reduced. There is a fall in the upper limit of the transaminases (ALT/AST). Alkaline phosphate concentrations are increased due to production from the placenta. Pregnancy is an inflammatory state and a small rise in baseline inflammatory markers should be taken in to account when interpreting blood test results (see Appendix Table 1). These physiological changes can complicate the diagnosis of abdominal pain during pregnancy.

Pregnancy is also a prothrombotic period and VTE remains one of the leading cases of direct maternal deaths in the UK. Sepsis, surgical procedures and dehydration can all contribute to an increased VTE risk in pregnant women who experience an acute abdomen.

Clinical assessment

History

In general, there is a correlation in the history of abdominal pain inside and outside of pregnancy. There are some condition-specific considerations but generally pathology will present in a similar manor. The mnemonic SOCRATES is a good basis to help with information gathering for abdominal pain (Figure 2).

Examination

Bedside inspection of the patient is important to assess if hydration status and obvious abnormalities like jaundice. Palpation should still involve assessment of all four quadrants of the abdomen, and the gravid uterus itself. Signs of peritonitis may be dampened due to the anatomical changes in pregnancy. Auscultation for bowel sounds and fetal heart should also be performed.

Investigations

Routine bed side investigations should be performed in all women presenting with abdominal pain. Observations, urine sample, and bloods depending on differential diagnoses should be undertaken.

Decisions regarding imaging should be made on a case-to-case basis whilst balancing the potential risks and benefits. Decision-making should involve consultation with the patient and exploration of risks. There should be discussions with the radiologist regarding modalities of imaging that will maximise diagnostic information while minimising radiation.

Ultrasound has a diagnostic accuracy of 90% for biliary pathology in the gravid patient. In appendicitis in pregnancy, the

Differential diagnosis of abdominal pain in pregnancy

Obstetric Causes

- - Labour/preterm labour
  - Braxton Hicks contractions
  - Chorioamnionitis
- - Placental abruption
  - Acute fatty liver of pregnancy
  - Pre-eclampsia/ HELLP Syndrome
- - Fibroids (degenerating)

Surgical Causes

- - Acute appenicitis
  - Cholecycitis
  - Renal colic
- - Pancreatitis
  - Bowel obstruction
  - Ovarian cyst

Medical Causes

- - Constipation
  - Urinary tract infection
  - Inflammatory bowel disease
- - GORD
  - Gastroenteritis
  - Pylonephritis
- - Myocardial infaction
  - Diabetic ketoacidosis

Others

- - Psychological
- - Trauma

Table 1

appendix is only visualised in up to 60% of cases and inconclusive for up to 90% of cases. In experienced hands, USS can be up to 80% sensitive and 95% specific in determining obstetrics and gynaecological causes of abdominal pain.

MRI provides good tissue imaging without ionising radiation. Gadolinium contrast crosses the placenta and may cause teratogenesis in early pregnancy so should only be used with caution.

In relation to CT imaging and ionising radiation, the literature suggests that the risk of spontaneous miscarriage, teratogenicity and childhood leukaemia start from maternal doses of 50 mGy. The majority of imaging modalities carry lower radiation levels (Table 2). The background incidence of childhood cancer and leukaemia is approximately 0.2–0.3%. Radiation may increase the incidence by 0.06% per 10 mGy delivered to the fetus.

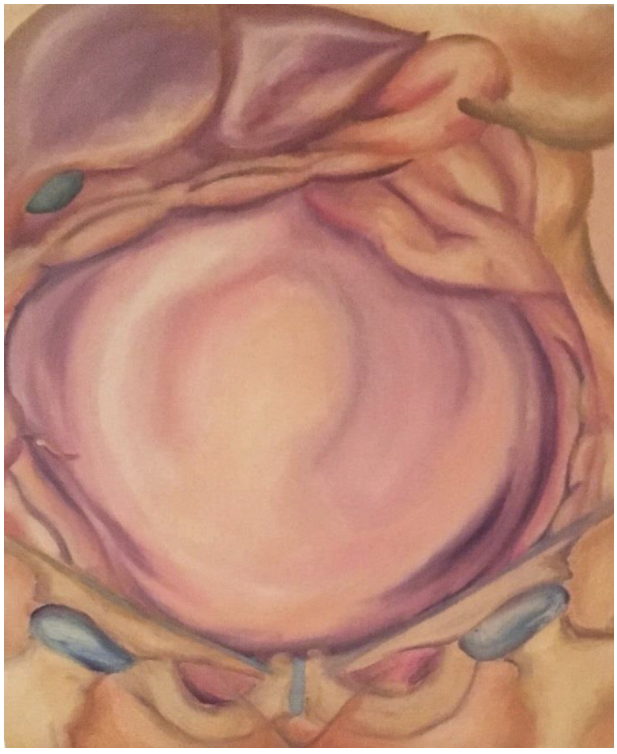

Figure 1 The uterus can displace normal abdominal anatomy. Image by Dr Ofuchi Egbujil

Practice points

- USS is imaging of choice if diagnosis possible with USS.
- CT can be performed in pregnancy if needed.
- Consent and explanation of risk is important when speaking to the mother.

Management

When weighing up management decisions, maternal well-being is the primary concern. Historically, surgery in pregnancy was avoided in the 1st and 3rd trimester in an aim to avoid miscarriage and pre term labour (PTL) respectively.

Operative laparoscopy is becoming the main stay of primary surgical intervention. The latest literature suggests that laparoscopy can be performed safely in any trimester. It is widely used in the management of appendicitis and cholecystitis. A study reported that the use of laparoscopic surgery has grown from 54 to 97% between 1998 and 2002 with no significant difference between PTL, birth weight or Apgars compared to women who undergo laparotomy.

During laparoscopy, an open or closed technique can be used. Due to the flattening of the diaphragm, it is recommended that lower CO_2 pressure (15 mmHg and below) are used for the

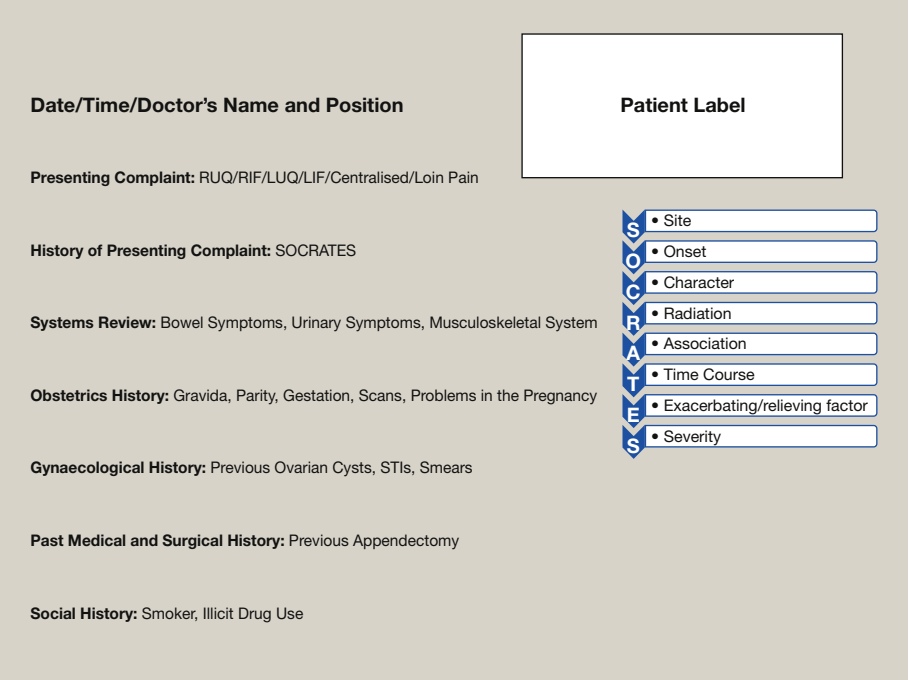

Figure 2 Simple template for history taking in abdominal pain in pregnancy.

laparoscopic procedure to avoid worsening maternal pulmonary function. There is no obvious correlation with worsening fetal outcome as a result of the CO_2 insufflation.

Anaesthetic considerations

A multidisciplinary approach is essential in the management of an acute abdomen in pregnancy. The aim is to:

- Optimise and maintain normal maternal physiological function
- Optimise and maintain uteroplacental blood flow and oxygen delivery
- Avoidance of unwanted drug effects on the fetus, (no anaesthetic drug has been shown to be teratogenic in observational and animal studies)
- Avoidance of stimulating the myometrium (oxytocic effects)
- Avoidance of maternal awareness during general anaesthesia
- Use of regional anaesthesia, if possible

Caution should be taken in fluid rehydration. Fluid replacement is essential in patients with an acute abdomen to ensure the haemodynamic circulation of the mother is maintained and in turn reduce the risk of fetal hypoxia. Due to reduced serum colloid osmotic pressure, there is a reduction in the colloid osmotic pressure/capillary wedge pressure putting pregnant women at a higher susceptibility to pulmonary oedema. This will be precipitated if overloaded or if there is increased capillary permeability, i.e. secondary to pre-eclampsia. Airway management is of particular concern in pregnancy and there is a high risk of aspirational pneumonia in pregnancy.

Obstetric considerations

When operating on a pregnant patient, especially above twenty weeks gestation, where possible the operating table should be placed in a left lateral tilt to reduce the pressure on the inferior vena cava and improve uteroplacental blood flow. This will help reduce the risk of fetal hypoxia. Fetal monitoring should be considered in all women with abdominal pain. There is limited data on the duration of fetal monitoring recommended. Pre and post-operative monitoring is sufficient.

There is a theoretical risk of preterm labour following an intra-abdominal procedure, but there is no evidence to support the use of prophylactic tocolytics. Clinicians should consider operating in a unit able to manage preterm neonates in case preterm labour commences.

Due to the increased venous thrombotic risk, meticulous attention to VTE thromboprophylaxis is required. It is recommended to have anti-embolism stockings or intermittent pneumatic compression (Flowtrons™) intraoperatively and VTE prophylaxis post op until fully mobile.

Radiation exposure for each modality of imaging

Modality	Fetal Dose (mGy)	Maternal dose (mSv)	Breast dose (mGy)
CT Abdomen	1.3–3.5	3.5–25	–
CT Pelvis	10.0–50	3.3–10	–
CT Abdo Pelvis	13–25	3.0–45	–
CTKUB	10.0–11	3.0–10	–
CT Aorta	6.7–56	4.0–68	16–130
Chest X-ray	0.0005–0.01	0.06–0.29	<0.04
Abdominal X-ray	0.1–0.3	0.01–1.1	–
Barium Enema	1.0–20	2.0–18.0	–
Small Bowel Studies	7	3.0–7.8	–

Table 2

Non-obstetric causes of abdominal pain in pregnancy

Appendicitis

Acute appendicitis is the most common non-obstetric emergency in pregnancy. Acute appendicitis is suspected in 1/600 to 1/1000 pregnancies and confirmed in 1/800 to 1/1500 pregnancies. It is more common in the second trimester than the third but 35% less common in the antepartum period compared to outside of pregnancy.

A retrospective study of 900 patients suggests that 96% of pregnant woman with appendicitis present with abdominal pain with 75% being in the RLQ and 20% in the RUQ. Nausea is experienced by 85% of women and vomiting in 70%. As the gravid uterus expands after 12 weeks, it stretches the anterior abdominal wall and distorts the omentum, resulting in the prevention of typical signs of guarding and rebound tenderness.

Raised inflammatory markers are usually synonymous with an acute appendicitis, however, a mild leucocytosis is also seen in uncomplicated pregnancies. A raised CRP in conjunction with leucocytosis is more indicative of appendicitis.

If the diagnosis is uncertain, then further imaging may be needed in the form of an USS or MRI. An USS can identify an enlarged appendix (sensitivity 67–100%, specificity 83–96%). If the USS is inconclusive, an MRI would be suggested.

Prompt management should be considered with appendicectomy. The laparoscopic approach is the preferred treatment for pregnant patients with acute appendicitis. Delay of treatment for more than 24 hours increases the likelihood of perforation. Perioperative broad-spectrum antibiotics covering both aerobic and anaerobic bacteria should be considered. Management with antibiotics alone should be avoided as it is associated with higher rates of failure.

There is an association with pre-term birth in pregnant women who undergo appendicectomy (both planned preterm delivery and spontaneous labour). The risk of pre-term delivery increases by gestational age. There are no significant differences between a laparoscopic and open approach in regards to limiting pre-term birth.

Due to the high risk of pre-term birth, clinicians should consider transferring patients to a unit with appropriate neonatal cover in case pre-term birth occurs. Steroids should be also considered, however there is limited research present to suggest the use of tocolysis for theatre.The overall maternal and neonatal morbidity is low at <10%. Maternal morbidity is more associated with other underlying maternal medical problems rather than the appendectomy itself. The neonatal morbidity is more associated with the gestational age of the infant at birth with better outcomes the further along in gestation.

Practice Points

- Abdominal pain secondary to appendicitis can present in all areas of the abdomen.
- The gravid uterus can prevent the identification of typical signs of appendicitis.
- Delay of treatment for over 24hrs increases the risk of perforation.
- Antibiotic treatment should not be used in isolation as there is an increased risk of failure.
- There is an increased risk of pre-term birth so preparation for this should be considered in the management.

Cholecystitis

Acute cholecystitis is the second most common indication for surgery in pregnancy. Pregnancy alters the liver and biliary function causing increased serum cholesterol, reduced bile salt production and reduced biliary motility. These factors combined results in increased cholelithiasis predisposing to stone formation. Cholelithiasis occurs in approximately 3.5% of pregnant women. Serious complications include jaundice, sepsis and cholangitis. Consideration should be taken for other obstetric cases of RUQ pain such as PET and HELLP Syndrome.

Typically, acute cholecystitis will present in a very similar manner in pregnancy as to outside of pregnancy. Most often it will present with sudden RUQ pain which persists up to 3 h post meal. The pain can be descried as colicky or constant pain and is associated with nausea. Cholelithiasis accounts for 90% of cases of cholecystitis. Risk factors for gallstones, apart from being female and pregnant, are: raised BMI and physical inactivity. Family history and digestive disorders also predispose to gallstone formation.

Diagnosis is made by history, examination and investigations. The patient could present with a tachycardia, tachypnoea and fever. In severe or complicated cases, they may present with jaundice. They may be tender in the right upper quadrant with a positive Murphy's sign. A palpable mass may also be felt. Blood tests should include; FBC, U&Es, LFT, C-reactive protein (CRP) and amylase.

USS should be the imaging of choice as it has a sensitivity of over 95% without the use of ionising radiation. It will typically show an enlarged gall bladder with thickened walled, with or without gallstones. A study suggests that 97% sensitivity and 76% specificity can be achieved by combining CRP and abdominal ultrasound.

Initial management should be admission and conservative management with analgesia, fluid replacement, bowel rest and broad-spectrum antibiotic.

40% of acute cholecystitis will require surgery in pregnancy. In the presence of complications, immediate cholecystectomy should be considered. There is evidence to suggest that in treating acute cholecystitis, the laparoscopic approach may be more appropriate in the 2nd trimester, however, further studies need to be seen with regards to the third trimester. Some women may need a delayed cholecystectomy (typically performed six weeks after symptoms) but this can be postponed until after pregnancy.

Endoscopy during pregnancy is associated with PTB and SGA with adjusted relative risk of 1.54 and 1.30 respectively. The evidence suggests no increase in stillbirth or congenital malformations.

Practice points

- Pregnancy increases the risk of acute cholecystitis.
- Pregnant women will typically present in the same way as non-pregnant patients.
- Diagnosis is typically a combination of clinical assessment, and investigations. USS has a good positive predictive value.
- Management should be conservative initially with awareness of a higher incidence of recurrence.

Bowel obstruction

Bowel obstruction (BO) in pregnancy is rare with an incidence of 0.001–0.003%. 70% are due to adhesions, 25% are secondary to volvulus. The remaining are due to malignancies, hernia and intussusception. The gravid uterus can compress the large bowels and is more commonly seen in the third trimester. BO carries a high fetal mortality of 17% and maternal mortality of 2%.

History may be vague and consistent with symptoms of pregnancy. Typically, the presentation is similar to the non-pregnant population, with abdominal pain, nausea, and vomiting. There may be diarrhoea or an absolute constipation (with inability to pass flatus or faeces).

The abdomen is often distended and tympanic. The uterus may not be easily palpable. There will be high pitched bowel sounds or absent bowel sounds. A rectal examination may reveal faecal loading or an empty rectum.

MRI is recommended as the imaging of choice when suspecting small bowel obstruction (SBO). The main aim is to identify the cause of the SBO and to determine if it will need surgical intervention or if conservative management would be appropriate.

Management of BO depends on the underlying cause. It is recommended that a multidisciplinary approach is taken. In the absence of suspected complications such as signs of peritonitis, strangulation, or bowel ischemia, initially management should be supportive. The patient should be kept nil-by-mouth with IV fluids with correction of electrolyte disturbances. Decompression of the bowel is one of the mainstays of treatment. Up to 72hrs of conservative management can be considered. Keep in mind that conservative measures carry a high failure rate of up to 94%. Surgical options should be discussed if there are signs of complications from the obstruction. A joint procedure between obstetrics and general surgeons is recommended with or without concurrent delivery of the fetus. The risks and benefits of laparoscopy versus laparotomy should be considered. There may be a high risk of bowel injury with the laparoscopic approach. However, there is an increased risk of forming more adhesions with an open approach.

Practice Points:

- Small bowel obstruction is very rare but carries a high maternal and fetal morbidity and mortality
- The biggest risk factor is previous operations and adhesions
- Initial presentation may be similar to that of non -pregnant women
- Imaging using USS and MRI is adequate to allow for a diagnosis of the obstruction
- Surgical intervention should be done with the surgical team with or without co-current delivery of the fetus

Renal colic

Renal colic in pregnancy is uncommon with an incidence of 1 in 1500 pregnancies. Renal colic usually presents with flank pain radiating from the loin to groin. The patient may have a history of previous renal stones. There may be associated sepsis secondary to pyelonephritis. Urinalysis may show leucocytosis or microscopic haematuria. USS diagnosis has an operative dependant sensitivity of 34%–86%. A mild physiological hydronephrosis can be seen in 90% of right kidneys and up to 67% of left kidneys during pregnancy.

MRI urogram has a sensitivity of 84%, a specificity of 100%, and a diagnostic accuracy of 100% for the diagnosis of acute ureteral obstruction in pregnancy.

Initial management should be conservative with IV fluids and antibiotics. A step-wise approach to analgesia should be taken with the avoidance of NSAIDS. There is a 70–80% successes rate of spontaneous passage of the stone. Early liaison with the urology team is advised. If conservative measures fail or complications like severe sepsis and renal impairment occur, urinary diversions in the form of a JJ stent or through a percutaneous nephrostomy (PCN) catheter should be performed. Definitive management can be deferred till after pregnancy if the condition persists.

Pancreatitis

The incidence of pancreatitis is 1 in 1000–10,000 births and occurs mainly in the third trimester. It presents in a similar manner to outside pregnancy including nausea, vomiting and upper abdominal pain radiating to the back. 7% of cases are associated with gallstones. The presence of symptoms with raised amylase and lipids level will be sufficient to diagnose pancreatitis. USS imaging is mainly to observe gallstones as the pancreas itself may be obstructed by bowels.

Usually pancreatitis is self-limiting and supportive therapy is appropriate. Pancreatitis has a low maternal mortality rate of <1% but a preterm labour rate of 20%. Fluid hydration, correcting electrolyte disturbances with bowel rest is usually sufficient to aid recovery. Recovery usually occurs within 5 days. Surgical intervention in the case of complicated pancreatitis should be considered in life threatening situations. Liaison with the surgeons is recommended.

Ovarian cysts/adnexal mass

Recent literature suggests that 5% of pregnancies are complicate by an adnexal mass. The majority of these are simple functional cysts and will often resolve after the 1st trimester. 20–22% of these will result in ovarian torsion in pregnancy with the greatest risk occurring at weeks 10–17 gestation.

In asymptomatic women who have an ovarian cyst in pregnancy, a follow-up USS can be performed at 16 weeks. If the mass appears benign, no follow-up is needed in pregnancy. If ovarian torsion is suspected, the gold standard treatment for ovarian torsion is surgery and this can be done laparoscopically or via laparotomy depending a case by case assessment.

Gastroenteritis

Gastroenteritis is usually a transient viral infection. It can cause cramping colicky abdominal pain and may be associated with nausea, vomiting and diarrhoea. It is imperative to isolate affected patients to avoid spread to other pregnant women who we know are immunocompromised.

GORD

GORD is the most common gastric complaint in pregnancy affecting up to 80% of pregnant women. It is exacerbated by physiological change of pregnancy leading to laxity of the

oesophageal sphincter and delayed gastrointestinal transit in pregnancy. Simple oral medication such as antacids, and H_2-recptor antagonists are recommended.

Inflammatory bowel disease

Usually patients with inflammatory bowel disease will be diagnosed outside of pregnancy. They would be aware of their condition and factors that exacerbate their condition. The majority of times conservative supportive management is all that is needed. Women may require steroid therapy and consultation with a gastroenterologist is essential.

Urinary tract infections and pyelonephritis

Urinary tract infections are the most common medical conditions of pregnancy. They usually present with asymptomatic bacteraemia and if untreated may progress to a urinary tract infection in 25% of cases and pyelonephritis. Patient may present with lower abdominal pain, dysuria and haematuria. In the case of pyelonephritis, they may present with sepsis. The main stay of treatment is with supportive therapy and antibiotics.

Pregnancy causes of abdominal pain

Labour

Consider labour or preterm labour as the cause of abdominal pain in any pregnant woman. If the clinical assessment suggests that the woman is in suspected preterm labour and she is 30–36 weeks pregnant, consider an ActimTM Partus test (Insulin-like growth factor binding protein-1). Maternal steroids for lung maturity and magnesium sulphate for neuroprotection should be considered in suspected preterm labour with tocolytics if appropriate. Consideration of an intrauterine transfer should be made in peripheral units with limited neonatal capacity.

Placental abruption

Placental abruption is the separation of a normally sited placenta from the uterine bed. It has an incidence of 0.6%. It can occur suddenly or gradually over hours. Bleeding may be concealed or frank with or without fetal compromise. The fetal compromise is a combination resulting in the haemodynamic instability of the mother and the reduced perfusion to the fetus. Blood tracking into the myometrial layer contributes to the 'woody hard' feel of the uterus on abdominal palpation and is a late sign.

Urgent action is needed in this situation to help to save the life of the baby and minimise morbidity for the mother. There can be considerable blood loss before there is maternal haemodynamic compromise. If it has been occurred over a prolonged period of time there is a risk of maternal DIC. Urgent delivery by caesarean section is required is there is evidence of maternal or fetal compromise

Degenerating fibroid

Usually fibroids in pregnancy are asymptomatic. Some women can have localised abdominal pain secondary to red degeneration or even torsion of a fibroid. Red degeneration of fibroids occurs in the second and third trimester of pregnancy. It is associated with a fibroid more than 5 cm in diameter with a pedunculated subserosal appearance. The pain associated with red degeneration has a necrotic origin however there is still debate regarding the true pathophysiology. One theory suggests that, that rapid fibroid growth results in the tissue outgrowing its blood supply leading to tissue infarction, hypoxia and necrosis.

Management is supportive therapy with analgesia. Myomectomy can be safely performed in the second trimester in cases with severe or intractable pain with comparable fetal and maternal outcomes.

Uterine rupture

Primary uterine rupture is rare and has an incidence of 1 in 10,000–15,000 births. Secondary rupture following a single LSCS is quoted to be 1 in 200. It can be catastrophic to both mother and baby. Pain is due to haemoperitoneum and irritation of the peritoneum. On examination, fetal parts may be felt superficially, vaginal bleeding may be present, or haematuria may be observed. A bedside ultra sound scan may aid in the diagnosis but, if suspected, immediate delivery by caseaserean section is warranted.

Musculoskeletal pain

Due to increased amounts of relaxin, oestrogen and progesterone, there is increased joint laxity during pregnancy. This is thought to be the underlying cause of pregnancy-associated lower back and pelvic girdle pain (Figure 3). Retrospective review suggests that most women will experience musculoskeletal discomfort in pregnancy.

Predictors of pelvic girdle pain and lower back pain include history of previous pain, raised BMI, and a history of joint hypermobility.

Pelvic girdle pain classically presents at the end of the 1st trimester, and peaks between the 24–36 weeks of gestation. Pelvic girdle pain affects the posterior iliac crest and the gluteal fold near the sacroiliac joints, with or without pubic symphysis pain. It can occasionally radiate into the posterior thigh.

Usually no investigations are warranted in pelvic girdle pain. If symptoms are severe and are associated with neurological symptoms it would warranted further investigate. Ideally imaging shoul be MRI or ultrasound.

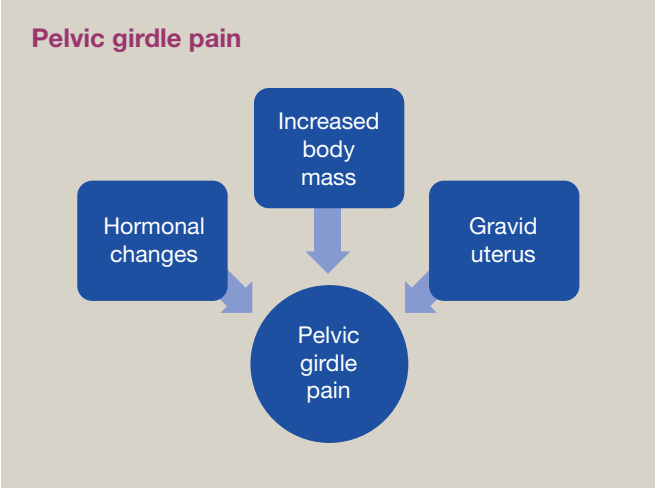

Figure 3 Pelvic girdle pain.

The main stay of the management of pelvic girdle pain is conservative management with physiotherapy input and oral analgesia.

Lumbar disk herniation occurs in about 1/10,000 and typically presents with unilateral radiating lower limb pain with a positive straight leg sign. 2% of these will progress to cauda equina.

Conclusion

There are a huge number of possible causes of abdominal pain in pregnancy, including rare causes such as aortic dissection and complications post bariatric surgery. A detailed history is always needed, taking into account specific background and risk factors. Careful examination with appropriate investigations will help to narrow down the potential differential diagnosis. Imaging can be performed with consideration of the fetus and balancing the risks and benefits. Surgery in pregnancy carries increased risk, however the maternal condition should be the primary consideration in the management of an acute abdomen in pregnancy. It is highly recommended to approach the pregnant women in a systematic, holistic manner and with multidisciplinary input. ◆

Appendix.

laboratory reference ranges in pregnancy

Laboratory Test	Non-Pregnant	Pregnant	1st Trimester	2nd trimester	3rd Trimester
Full Blood Count					
Hb (g/dL)	12–15	11–14	–	–	–
WBC X 10-9/L	4–11		–	–	–
Platelets X 10-9/L	1500–400	150–400	–	–	–
MCV (fL)	80–100	80–100	–	–	–
CRP (g/L)	0–7	0–7	–	–	–
Renal Function					
Urea (mmol/L)	2.5–7.5	–	2.8–4.2	2.5–4.1	2.4–3.8
Creatinine (μmol/L)	65–101	–	52–68	44–64	55–73
K (mmol/L)	3.5–5.0	3.3–4.1	–	–	–
Na (mmol/L)	135–145	130–140	–	–	–
Uric Acid (mmol/L)	0.18–0.35		0.14–0.23	0.14–0.29	0.21–0.38
24-h Protein (g)	<0.15	<0.3	–	–	–
PCR (mg/mmol)		<30	–	–	–
LFTs					
Bilirubin (μmol/L)	0–17		4–16	3–13	3–14
Total Protein (g/L)	64–86	48–64	–	–	–
Albumin (g/L)	35–46	28–37	–	–	–
AST (IU/L)	7–40		10–28	11–29	11–30
ALT (IU/L)	0–40	6–32			
GGT (IU/L)	11–50		5–37	5–43	3–41
ALP (IU/L)	30–130		32–100	43–135	133–418
Bile Acids (μmol/L)	0–14	0–14	–	–	–
TFTs					
fT4 (pmol/L)	9–26		10–16	9–15.5	8–14.5
fT3 (pmol/L)	2.6–5.7		3–7	3–5.5	2.5–5.5
TSH (mu/L)	0.3–4.2		0–0.5	0.5–3.5	0.5–4

Table A1

radiation risk in relation to gestational age

Maternal Gestation	< 50 mGy (< 5 rad)	50–100 mGy (5–10 rad)	> 100 mGy (> 10 rad)
0–2 weeks (0–14 days)	None	None	None
3rd and 4th weeks (15–28 days)	None	Probably none	Possible spontaneous miscarriage
5th–10th weeks (29–70 days)	None	Potential effects are scientifically uncertain and probably too subtle to be clinically detectable	Possible malformations increasing in likelihood as dose increases.
11th–17th weeks (71–119 days)	None	Potential effects are scientifically uncertain and probably too subtle to be clinically detectable.	Risk of diminished IQ or of learning difficulties, increasing in frequency and severity with increasing dose
18th–27th weeks (120–189 days)	None	None	IQ deficits not detectable at diagnostic doses.
>27 weeks (>189 days)	None	None	None applicable to diagnostic medicine.

Table A2

abbreviations and explanations

ABG	arterial blood gas	mmhg	Millimeters of Mercury
ALT	Alanine aminotransferase	mSv	Millisievert
AST	Aspartate transaminase	MRI	Magnetic resonance imaging
BO	Bowel Obstruction	NSAIDS	Non-steroidal anti-inflammatory drugs
BMI	Body mass index	O&G	Obstetrics and gynaecology
Co2	Carbon dioxide	PCN	Percutaneous nephrostomy
CRP	C-reactive protein	PET	Pre-eclamptic toxaemia
CT	Computed tomography	PPH	Postpartum haemorrhage
CTKUB	CT of the kidneys, ureters and bladder	PTB	Pre-term birth
DIC	Disseminated intravascular coagulation	PTL	Pre-term labour
FBC	Full blood count	PVB	Per vaginal bleed
GORD	Gastro-oesophageal reflux disease	RLQ	Right lower quadrant
HELLP	Haemolysis(H), elevated liver enzymes (EL) and low platelet count (LP)	RUQ	Right upper quadrant
JJ Stent	Ureteric stent	SBO	Small bowel obstruction
LSCS	Lower (uterine) segment caesarean section	SGA	Small for gestational age
LFTs	Liver function tests	U&Es	Urea and electrolytes
LLQ	Left lower quadrant	USS	Ultrasound scan
LUQ	Left upper quadrant	UTI	Urinary tract infection
mGy	Milligray	VTE	Venous thromboembolism

Table A3

History and investigation for non-obstetric related pain

	Appendicitis	Bowel Obstruction	Constipation	Cholecystitis	DKA	GORD	Inflammatory Bowel Disease	Liver Disease and Disease of the Spleen	Ovarian Cysts/ Adnexal Mass	Pancreatitis	Psychogenic	Renal Colic	Trauma, domestic violence, assault	Urinary Retention
Pain														
Site	Right Iliac fossa, right side of the abdomen	Generalised, colicky abdominal pain	Generalised, Left iliac fossa	RUQ pain	Generalised	Epigastric/ retrosternal pain	Generalised	RUQ pain	Unilateral/Lower abdominal pain	Upper abdominal pain	Generalised	Flank Pain	Localised	Suprapubic pain
Onset	Gradual	Gradual	Gradual	Sudden, hours after a meal	Gradual	Gradual	Gradual	Acutew or Gradual	Sudden	Sudden	Sudden	Gradual	Time of Trauma	Gradual
Character	Sharp pain	Colicky	Constant, colicky	Colicky remitting pain	Constant	Burning pain	Constant, colicky	Dull/Sharp	Constant/ Intermittent	Constant, burning	Sharp	Colicky Pain	Varies	Sharp
Radiation	Initially from umbilicus radiating to the left iliac fossa	LIF	Nil	Back and flank	Nil	To the back	Sharp, cramping pain	Nil	Vomiting	Towards the back	Varies	Loin to groin	Varies	—
Association	Nausea, vomiting, anorexia, diarrhoea	Nausea, vomiting, Abdominal distention	Absence of flatus, anorexia	Nausea and Vomiting	Raised BMs	With eating for gastric, improves with duodenal ulcers	Bloody stools	Nausea and Vomiting	Known ovarian cysts	Haemodynamic shock	Stress	Nausea and vomiting	Varies	UTI
Time course	Hours to days	Hours to days	Days	Over minutes or hours	Hours or Days	Days and weeks	Hours to days	Days to weeks	Minutes to hours	Minutes to hours	Minutes to hours	Hours to days	Time of Trauma	Hours or days
Exacerbation/Elevating factors		Eating may worsen symptoms	Released with opening bowels	Worse when eating fat rich foods	Uncontrolled BMs	Worse at night	Diet	—	Nil	Eased leaning forward	Emotional status/Presence of support system	Dehydration	Movements	Helped with catheter
Severity	Moderate to severe	Moderate to Severe	Mild to moderate	moderate to severe	Mild to moderate	Mild to Moderate	Mild to moderate	Moderate to Severe	Moderate to Severe	Moderate to Severe	Moderate to Severe	Moderate to severe	Mild to moderate	Moderate to severe
Other	Bowel symptoms	No passed flatus or stools	Low fibre diet	Pale stools	Known T1 diabetic	Raised BMI	Anorexia	Paracetamol use/ Alcohol use	Nausea and Vomiting	Recent cholecystitis	Mental Health History	UTI	—	UTI
Fetus														
Fetal Movements	Reduced FMs or no Change	Reduced FMs or no Change	No Change in FMs	No Change in FMs	Reduced FMs or no Change	No Change in FMs	Reduced FMs or no Change	Reduced FMs or no Change	Reduced FMs or no Change	Reduced FMs or no Change	No Change in FMs/ reduced	No Change in FMs	Reduced FMs or no Change	Reduced FMs or no Change
CTG/FH	Normal/		Normal	No Change in FMs	Fetal acidemia in severe cases	Normal	Normal	Normal	Normal	Normal/	Normal	Normal	Varies	Normal
Examination														
Observations	Low grade pyrexia	Tachycardia/ Tachypnea	Normal	Normal/ Haemodynamic compromise if complications	Normal	Mild pyrexia, tachycardia/ Tachypnoeic	Tachycardia	Normal	Normal/ Haemodynamic compromised	Normal	Normal	Varies	Normal	
Examination	Pain at McBurney's point	High pitched or absent bowel sounds	Loaded rectum	Murphy's Sign positive	Ketosis	Normal	Generalised tenderness	Palpable liver/ Spleen	Very tender to touch	Upper abdominal pain	Normal	Flank tenderness, Haematuria	Pain specific to injury	Palpable Bladder
			Diagnosis of exclusion											
Investigations														
Bloods	Mild rise in CRP	Raised K+/electrolyte imbalance		Deranged LFTs		Normal	Raised inflammatory markers, raised auto immune markers	Raised LFTS	Slight rise in inflammatory markers, slight rise in CRP		Normal	Deranged U&Es	Pain specific to injury	Deranged U&Es

Table A4

History and investigation for non-obstetric related pain

	Acute fatty Liver of Pregnancy	Braxton-Hicks contractions	Chorioamnionitis	Degenerating Fibroid	Labour	Ligamentous	Miscarriage	Musculoskeletal Pain	Placental Abruption	Pre-eclampsia	Uterine Rupture
Pain											
Site	Epigastrium pain, RUQ.	Generalised	Generalised	Site of Fibroid	Generalised	Bilateral	Lower abdominal pain/Suprapubic pain		Generalised abdominal Pain	Epigastric, RUQ	Lower abdominal pain
Onset	After 30 wks (35–36wks)	Sudden, gradually progressing	During in labour	Gradual	Gradual	12–16wk gestation	Over a few hours		Gradual or sudden	After 20weeks gestation	Sudden
Character	Constant	Tightening's	Ache	Sharp	Intermittent, cramping, tightening	Sharp, short lived	Crampy, period like pain Can be sharp		Tightening's and cramping, sharp	Constant	Sharp ripping
Radiation	Nil	To the back, to the pelvis	Nil	To the back, lower abdomen	To the back	To the sides and down	Downwards		Nil	Localised	Nil
Association	Nausea, vomiting, anorexia. Mild PET, HTN, Coagulopathy, Jaundice, ascites,	Reduced Fatal Movements	Fever, material tachycardia, fetal tachycardia and CTG changes	Known fibroids	Contractions/ Tightenings	–	Bleeding, light-headedness		Wood abdomen, abnormal CTG	HTN, Proteinuria, Elevated transaminases, thrombocytopenia, FGR, nausea and vomiting, haemolysis, Tenderness in RUQ	Previous LSCS, PVB, CTG changes
Time course	Days	Hours, days, intermittently throughout 3rd trimester		Hours and days	Hours	Days and weeks	Over a few hours to days		Minutes to hours	Minutes to hours	Minutes to hours
Exacerbation/ Elevating factors	Nil	To the back, to the pelvis	Hour over labour	Nil	–	Movements	Nil		Nil	Raised BP	Nil
Severity	Moderate	Mild to overate	Mild	Moderate to Severe	Moderate to Severe	Mild to Moderate	moderate to severe		Moderate to Severe	Mild to moderate	Mild to moderate
Other	Male fetus 70%	No cervical change	–	–			History of miscarriage, high bHCGs, previously confirmed intrauterine pregnancy		PVB		–
Fetus											
Fetal Movements	No change in Fm, or Reduced FM	No change in Fm, or Reduced FM	No change in Fm, or Reduced FM	Normal FM	No change in Fm, or Reduced FM	No Change in FMs	Reduced/Absent	No Change in FMs	Reduced FMs, CTG abnormalities	No change in Fm, or Reduced FM	Reduced FMs, CTG abnormalities
CTG	Normal/Abnormal is severe	Normal, tightening's may be seen	Fetal Tachycardia, reduced variability	Normal	Normal	Normal	–		Abnormal CTG	CTG Change if severe	Abnormalities
Examination											
Observations	May have associated raised BP	Normal Obs	Increased temperature on VE	Tachycardia	Normal	Normal	Normal	Normal	Haemodynamically unstable	Raise BP	Tachycardia, Low BP
Examination	Tender RUQ Tenderness	Palpable tightening, no Cervical Change	Tender on palpation	Tender over fibroid	Palpable contractions, Cervical change	Normal	Abdomen tender	Normal	Wood abdomen, PVB,	Increased reflexes	Raise in height of presenting part, palpable presenting part
Investigations	Proteinuria, Hypoglycaemia, thrombocytopenia, Elevated white cells										
Bloods	Elevated Liver Enzyme	Normal	Raised inflammatory markers	Mild Leucocytosis	Normal	Normal	Rule out septic abortion	Normal	Normal if very acute. Low HB, DIC over longer period of time	Abnormal PET Bloods	Low Hb if internal bleeding
Imaging	USS/CT/MRI - Normal or hepatic Haematoma	Not Applicable	Not Applicable	Fibroid with degenerative changes on USS	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	N/A

Table A5

FURTHER READING

Kavic Michael S, Lanzafame Raymond J, Lindsay Michael K, Polk Travis M. Non-obstetric surgery during pregnancy: a comprehensive guide. 1st ed, 2019. edition (October 30, 2018).

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Guidelines for diagnostic imaging during pregnancy and lactation. Committee opinion No. 723. American college of obstetricians and gynecologists. *Obstet Gynecol* 2017; **130:** e210–6.

Pearl, et al. Guidelines for the use of laparoscopy during pregnancy, 2017.

Practice points

- Full clinical assessment is imperative for the management of an acute abdomen in pregnancy.
- Patients will present in similar ways inside and outside of pregnancy.
- Imaging should be tailored to the differential diagnosis.
- Most radiation exposure needed for imaging is below the threshold for damage to the fetus but US and MRI should be considered first line.
- Surgery can be undertaken at any gestation following risk-benefit considerations.
- Laparoscopic surgery is becoming the main stay of treatment in an acute abdomen in and outside of pregnancy and is being performed in later gestations.
- Anaesthetic considerations are important when surgery in pregnancy is contemplated.
- There is a risk of pre-term labour in any women who undergoes a surgical intervention.