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Colicky patients: is radiology necessary?

Introduction

Colicky abdominal pain is an intermittent spasmodic pain within the abdominal cavity, characterized by multiple recurrent episodes. The severity of the pain can vary from mild abdominal cramps to very intense, acute attacks, which require hospitalization and treatment with intravenous analgesia. Between recurrent episodes, patients usually feel well and are pain and symptom free.

Colicky pain is usually caused by spasm, obstruction or distention of the hollow viscera. The most common causes of colicky pain include biliary and renal calculi, various bowel pathology with irritable bowel syndrome or chronic lead poisoning (rare).

Biliary colic

Biliary colic often presents as multiple episodes of severe abdominal pain – constant or spasmodic, mainly in the epigastrium and right upper quadrant. Pain usually starts a few hours after a meal, lasts from 1–5 hours and frequently occurs at night. It may radiate to the back or right scapula and may be associated with nausea, vomiting, chest pain and fever.

Biliary colic is caused by temporary obstruction of the cystic or common bile duct by gallstones. Calculi within the gall bladder are usually asymptomatic and clinical symptoms are present in only 1–4% of patients. Once symptoms occur, patients have a 50% chance of having another attack within 1 year. There is also 1–2% per year risk of developing acute cholecystitis or other complications (Gore et al, 2007).

Cholelithiasis

About 10% of the adult population in the UK have gallstones and these are twice as common in women than men. However,

men with calculi are more likely to develop cholecystitis. Predisposing factors include obesity, increasing age, elevated triglyceride levels, ileal intestinal disease, rapid weight loss, diabetes mellitus, pregnancy or haemolytic diseases.

Biliary sludge (*Figure 1*) is a reversible suspension of precipitated particles (cholesterol monohydrate crystals, calcium-based crystals, various salts) in mucous liquid phase within the bile. Large particles (1–3 mm) are called microliths and are an intermediate step in the formation of biliary calculi (approximately 12.5% of patients with biliary sludge will develop calculi).

There are three main types of biliary calculi:

1. Cholesterol stones which are usually multiple, small, white or yellow; 85% of these are not visible on the plain abdominal radiograph
2. Pigmented stones which are usually small (2–5 mm), black or dark brown and contain calcium salts of bilirubin, phosphate and/or carbonate. These are radio-opaque in 50% of cases and can be demonstrated on plain film
3. Mixed stones are most common, and are often multiple, and different shapes and sizes.

Ultrasonography is the 'gold standard' examination for patients with biliary colic. It provides very detailed views of the gall bladder, biliary tree and hepatic parenchyma, without the increased risk of ionizing radiation.

Figure 1. Biliary sludge in the lower part of the gall bladder on ultrasound examination.



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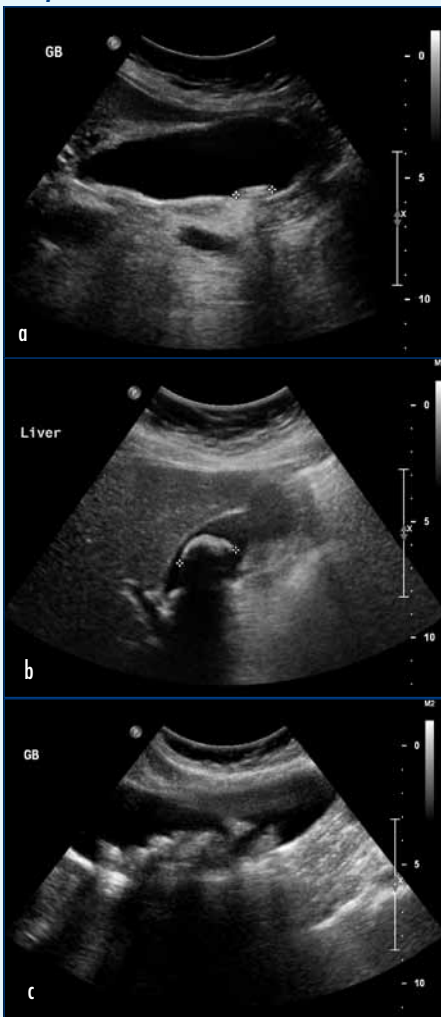
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Gallstones are visible as echogenic foci with strong posterior acoustic shadowing (Figure 2). They are mobile and can form layers in the posterior part of the gall bladder, dependent on the patient's position.

Biliary sludge is also echogenic, but does not show acoustic shadowing unless it contains micro-calculi. Ultrasound shows approximately 96–98% specificity and sensitivity in detecting calculi within the gall bladder.

Plain films and computed tomography scans are not commonly used in investigating biliary colic. Only 15–20% of stones are radio-opaque and visible on plain films (Figure 3). These are usually an incidental finding, when a plain abdominal radiograph has been performed for a different abdominal complaint (in different clinical situations).

Figure 2. Biliary calculi in the gall bladder on ultrasound examination: (a) small calculus adjacent to posterior wall, (b) large single calculus, (c) multiple small calculi.



Computed tomography reveals only 79% of gallstones seen on ultrasound, because bile and calculi are similar density and attenuation (Figure 4).

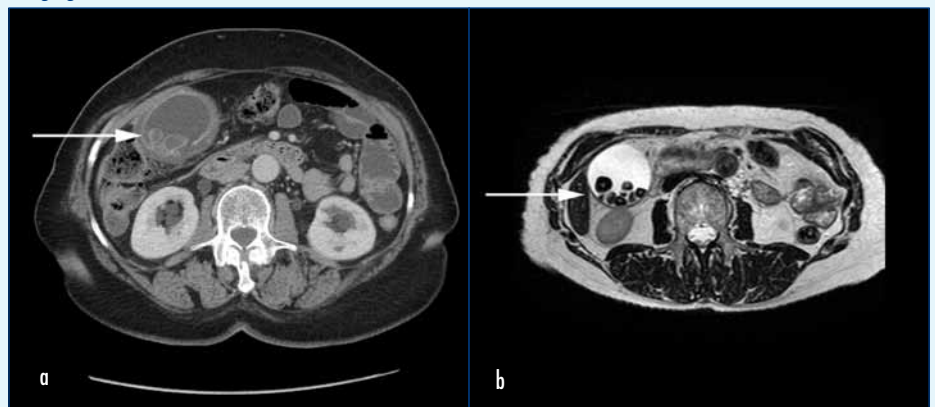
Owing to high spatial resolution, magnetic resonance imaging is a better technique for visualization of the biliary system. Because of the long scanning time and high cost of this examination compared to ultrasonography, magnetic resonance imaging is commonly used as a problem-solving technique. It is used for evaluation of the common biliary ducts when there is strong clinical suspicion of choledocholithiasis and other complications of biliary calculi.

The most common complications with gallstones include: cholecystitis, choledocholithiasis, cholangitis, pancreatitis, Mirizzi's syndrome and gallstone ileus.

Figure 3. Single calculus on plain abdominal X-ray.



Figure 4. Multiple calculi in the gallbladder on (a) computed tomography and (b) magnetic resonance imaging examination.



Cholecystitis

Cholecystitis occurs following prolonged obstruction of the cystic duct by an impacted stone. It leads to inflammatory changes, gall bladder distention, wall oedema and eventual necrosis. Acute cholecystitis develops in approximately 20% of patients with untreated biliary calculi.

Clinical symptoms are similar to biliary colic, but pain is usually more severe, lasts much longer and is more often accompanied by low-grade fever and general complaints.

Cholecystitis (Figure 5) produces diffuse wall thickening and gall bladder distention, with a positive sonographic Murphy sign (maximal pain over the gall bladder when this area is compressed by ultrasound transducer). The gall bladder wall may be irregular with changes in the surrounding soft tissue. A small amount of free fluid may also be present around the gall bladder.

Complications of acute cholecystitis include gangrenous cholecystitis and perforation. Perforation occurs in less than 20% of undiagnosed patients and is usually encapsulated, with formation of a pericholecystic abscess (Figure 6).

Choledocholithiasis

Choledocholithiasis (Figure 7) describes the presence of biliary calculi within the lumen of the common bile duct. In the majority of cases, these are gall bladder calculi which have migrated into the biliary tree. Primary duct stones are very rare and may form within the duct secondary to biliary stasis, bacterial or parasitic infection.

Duct stones may present with a variety of clinical symptoms: biliary colic, jaundice,

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abnormal liver function, recurrent pancreatitis or bacterial cholangitis. Calculi may become impacted at the level of the ampulla of Vater and present as a surgical emergency as a result of biliary obstruction.

Ultrasonography remains the first imaging examination in these patients, but is less specific than in simple biliary colic. The common hepatic duct is usually clearly visible on ultrasonography, but the

distal part of the common bile duct is more difficult to trace and may be obscured by overlying bowel gas. Duct stones can be visualized in 55–75% of patients, because of their small size and, often, a lack of acoustic shadowing. Other abnormalities may have a similar appearance, including blood clots, sludge, infection or soft tissue lesions. However, dilatation of the common bile duct should raise the suspicion of stones and the need for further examinations.

Computed tomography is slightly more sensitive than sonography, particularly in visualizing distal stones in a minimally dilated bile duct. However, magnetic resonance cholangiopancreatography is the optimum technique for examining the biliary tree. Calculi as small as 1 mm can be demonstrated, together with fine details in the wall structure of the biliary and pancreatic ducts. Magnetic resonance cholangiopancreatography has become a very popular examination and is often performed to exclude ductal calculi in patients undergoing laparoscopic cholecystectomy.

Ductal calculi can be also demonstrated as a filling defect with endoscopic retrograde cholangiopancreatography, intraoperative cholangiogram or percutaneous transhepatic cholangiography. These are interventional procedures and reserved for the treatment of calculi and obstructive jaundice rather than simple imaging techniques.

Oral cholecystography and nuclear medicine imaging are no longer used in diagnosis of biliary colic and have been replaced by sonography and magnetic resonance imaging.

Mirizzi's syndrome

This is caused by gallstone impaction in the infundibulum of the gall bladder or cystic duct. This leads to focal inflammation and oedema, which produces a mechanical obstruction of the adjacent common bile duct (Figure 8). Mirizzi's syndrome should be suspected in patients with cholecystitis who develop abnormal liver function and obstructive jaundice.

Gallstone ileus

Gallstone ileus is a complication of chronic cholecystitis and is caused by erosion of a large stone into the gastrointestinal tract with its subsequent obstruction. The gall-

Figure 5. Computed tomography of the abdomen with intravenous contrast show (a) moderate and (b) severe cholecystitis. a. Multiple gallstones and moderate wall thickening with pericholecystic fluid can be seen. b. There is marked gall bladder wall thickening, severe inflammatory changes within the porta hepatis and adjacent structures.

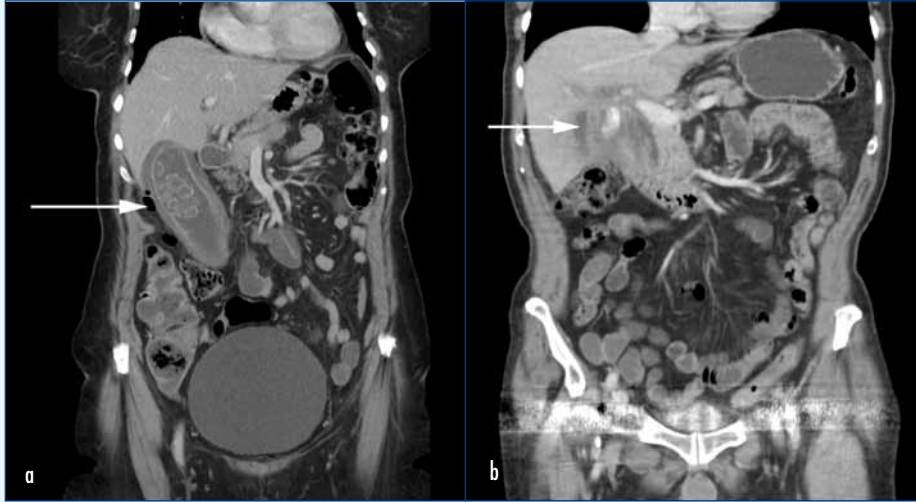


Figure 6. Magnetic resonance cholangiopancreatography showed multiple calculi within a gall bladder, cystic duct and common bile duct. a. Coronal T2WI. b. Three-dimensional maximum intensity projection. Perforation of the gall bladder with calculi visible outside gall bladder lumen and formation of a pericholecystic abscess.

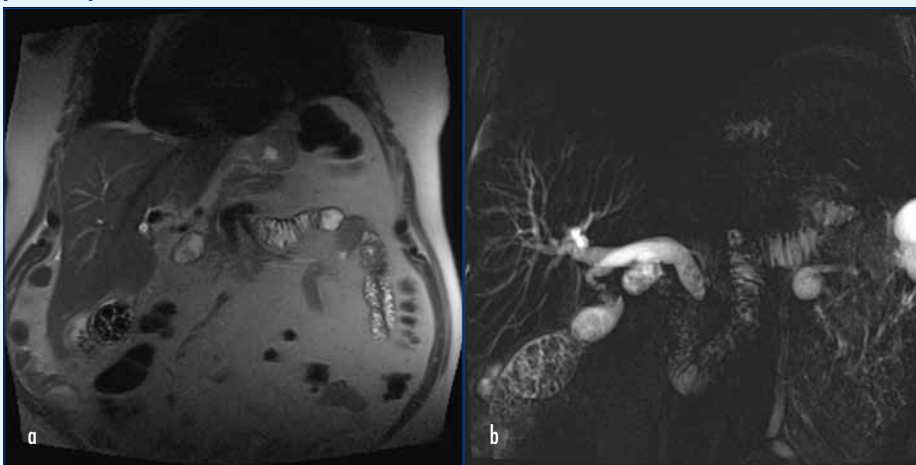
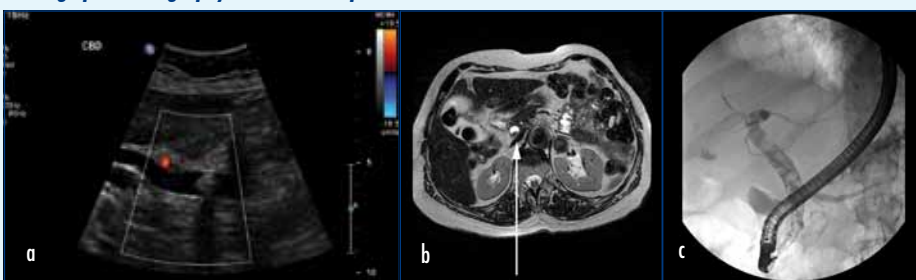


Figure 7. Biliary calculi within common bile duct – single calculus in the dilated common bile duct on (a) ultrasound and (b) magnetic resonance imaging examination. c. Endoscopic retrograde cholangiopancreatography showed multiple common bile calculi.



stone usually erodes directly to the duodenum and must be more than 2 cm in diameter to cause an obstruction.

Radiological signs include: air in the biliary tree, intestinal obstruction and ectopic calcified gallstone surrounded by intestinal gas in the obstructed loop of bowel.

Renal colic

The clinical presentation of renal calculi is very variable. A small calculus passing through the ureter may cause significant and agonising pain, while a more substantial stone within the renal parenchyma can be asymptomatic for many years. Large staghorn calculus within the pelvicaliceal system may also be asymptomatic, but may gradually destroy the kidney as a result of chronic obstruction and infection. Haematuria is usually related to renal colic and caused by passage of irregular calculus through the ureter. Microscopic haematuria can be found even in asymptomatic patients.

Acute onset of severe flank pain, radiating to the groin, nausea and vomiting are characteristic clinical symptoms of renal colic caused by acute obstruction.

Most of the pain receptors responsible for renal colic are located in the submucosa in the renal pelvis, calyces, renal capsule and the upper part of ureter. Acute distention seems to be the most important factor in development of colicky pain, followed by acute spasms, local irritation and hyperperistalsis.

The severity of the pain depends on the degree and localization of the obstruction, not the size of the renal calculus.

The composition of renal calculi varies but includes:

- Calcium stones (calcium oxalate) (70–80% of calculi)
- Struvite stones (magnesium ammonium phosphate) (15–20% of calculi)
- Cystine
- Uric acid
- Xanthine
- Matrix.

There are multiple conditions which predispose to formation of urinary calculi: obstruction, urinary tract infection (especially caused by urea-splitting bacteria like *Proteus* spp.), hot climate, dehydration, prolonged immobilization, several congenital conditions (horseshoe kidney,

diverticula, medullary sponge kidney), Crohn's disease, hypercalcaemia, hypercalcuria, hormonal abnormalities (Cushing syndrome, adrenal insufficiency, hyperparathyroidism) and many others.

Calculus disease affects about 5% of the population in the western hemisphere, with a steadily increasing incidence.

The standard plain radiographic examination of the urinary tract (Figure 9), known as kidneys, ureters, bladder (KUB) consists of full length abdominal X-ray with upper abdominal (cross kidneys) film. The patient lies in the supine position and a long radiograph is performed in inspiration, while a cross kidney film is obtained in expiration, to include the movement of the renal outline in the breathing circle.

Around 90% of renal calculi are radio-opaque and can be seen on the plain film. However, a plain radiograph is unreliable in diagnosis of urinary calculi, with an accuracy of only about 50%.

Calculi in the ureters and bladder can be easily missed, as part of these overlie the dense skeletal structures (spine and pelvis). Small focal shadows from faecal material and bowel gas can also easily mimic or mask small calculi (Figures 9 and 10).

The intravenous urogram is a classic routine investigation in urology. It consists of a series of plain X-rays taken after injection of intravenous contrast – immediately, 5 minutes, 15 minutes (and as many as required) and postmicturition to visualize an opacified urinary tract (calyces and pelvis in kidney, ureters and urinary bladder) (Figure 11). Non-radio-opaque calculi are seen as constant filling defects within the opacified urinary system.

Routine ultrasound examination of the urinary tract includes both kidneys and full urinary bladder. It is an easily available and quick examination to exclude urinary obstruction. Unfortunately, the ureters are not visualized because of the position and overlying bowel gas. Rarely,

Figure 8. Patient with Mirizzi's syndrome caused by large calculi impacted in markedly dilated cystic duct – (a) coronal computed tomography reconstruction, (b) axial computed tomography scan, (c) magnetic resonance imaging - axial T2WI.

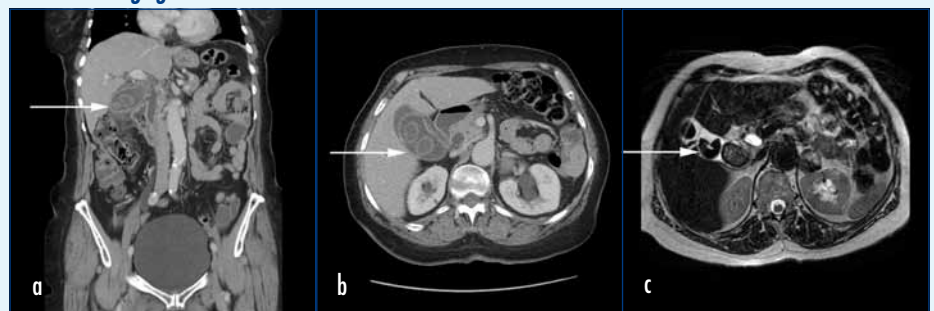
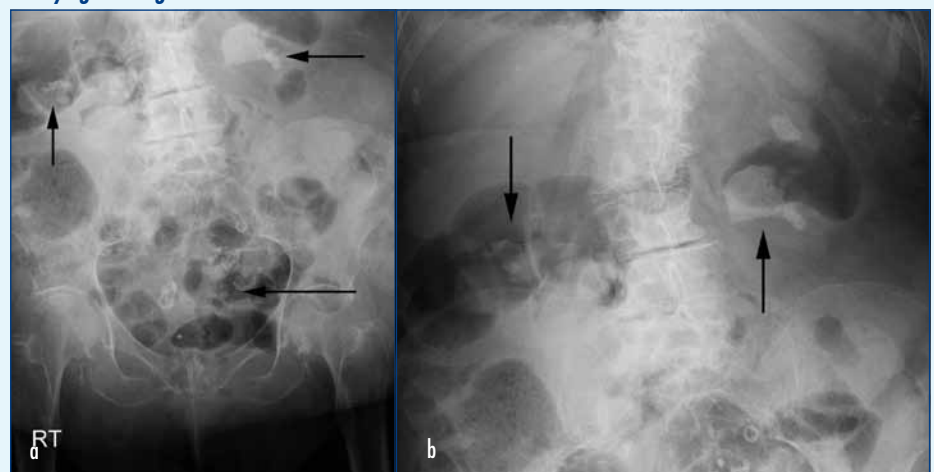


Figure 9. Kidney, ureters, bladder (KUB) X-rays show bilateral staghorn calculi in the kidneys with multiple small calculi in the pelvis (a) full abdominal X-ray in taken in inspiration, (b) upper abdominal film taken in expiration. Calculi in the pelvis and in the right kidney are not clearly visible as a result of overlying bowel gas and faecal residue.



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severely dilated ureters containing calculi may be seen on ultrasound examination (Figure 12).

Renal calculi are similar to biliary stones in sonographic appearance – well-defined echogenic foci with strong posterior acoustic shadowing. However, they are more difficult to detect if they are smaller than 5 mm or localized within the renal parenchyma or non-dilated renal pelvis (Figure 13).

The computed tomography scan remains the examination of choice for patients with acute renal colic. An unenhanced (without

intravenous contrast) scan through the abdomen and pelvis is performed, with technical parameters optimized to low radiation dose (as little as 3 mSv can be achieved, when the standard radiation dose of a computed tomography of the abdomen is 10 mSv).

Calculus is visualized on computed tomography (Figure 14) as a small well-defined area of high attenuation within the kidneys, ureters or urinary bladder and needs to be distinguished from phleboliths and other soft tissue calcifications. Secondary signs of calculi which develop

as a result of obstruction include: hydronephrosis, dilatation of ureter, perinephric stranding, swelling of affected kidney and periureteral oedema.

Spiral computed tomography is a highly accurate examination in patients with renal colic, with a sensitivity of 94% and specificity of 97%, compared with 52% and 94% for intravenous urogram and 19% and 97% for ultrasound (Sutton, 2002).

The major advantages of computed tomography include: direct visualization of the urinary stone and its detailed meas-

Figure 10. Calculi in the right kidney and right ureter on a plain abdominal film. Renal calculi overlying soft tissue are more visible than calcifications in the pelvis.

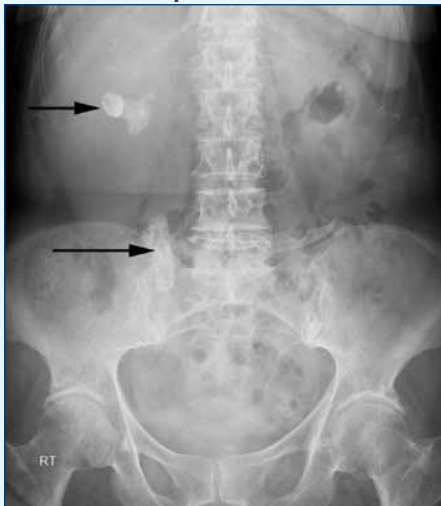


Figure 11. Film from intravenous urogram series showing normal appearance of urinary bladder and right collecting system. There is a large left-sided calculus causing obstruction and marked hydronephrosis of the left kidney, and a stent within the left ureter.



Figure 12. Patient with severe dilatation of the right ureter as a result of large urinary calculi. a. Ultrasound, (b) computed tomography abdomen, (c) antegrade ureterography through a nephrostomy tube.



Figure 13. Renal calculi visible on ultrasound scan as high attenuation areas with strong posterior shadowing. a. Patient with hydronephrosis and dilated calyces – calculi easily visible, (b) no dilatation of collecting system, more difficult visualization of renal stones.

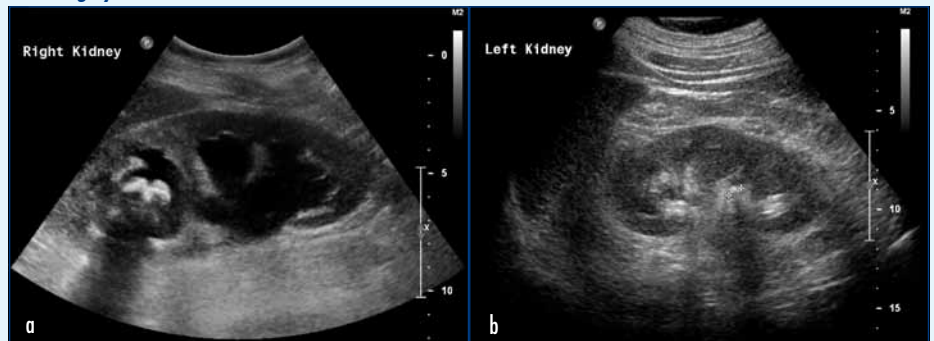
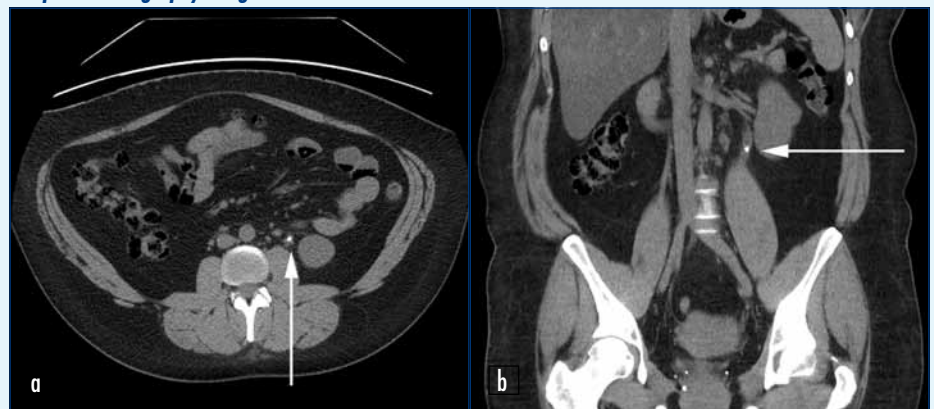


Figure 14. Small calculus in the upper part of a non-dilated left ureter – (a) axial, (b) coronal unenhanced computed tomography images.



urement, good visualization of the ureters, imaging of potential complications and examination of other intra-abdominal organs with the possibility of making an alternative diagnosis (diverticulitis, appendicitis, cholecystitis) in patients with acute abdominal pain.

The majority of calculi progress down the ureter spontaneously – approximately 95% of calculi are smaller than 4 mm. The time of passage relates to the size of the calculus – the mean time of passage of a calculi which is 2 mm in diameter is around 8 days, whereas calculi over 4 mm in diameter will take a mean of 22 days.

Generally, renal stones smaller than 5–6 mm in diameter do not require surgical intervention.

Calculi most commonly obstruct the ureters at the sites where they are relatively narrow: at the pelvic-ureteric junction, over the sacrum, where the ureter crosses the iliac artery or at the vesico-ureteric junction, or in the intramural distal ureter.

Complications of urinary calculi

Acute and chronic hydronephrosis, calyceal rupture, fistula formation, calculous pyelonephritis, abscess formation, pyonephrosis and urinary sepsis, ureteral scarring and stenosis, xylogranulomatous pyelonephritis in presence of staghorn calculus, squamous metaplasia or loss of renal parenchyma (and function) as a result of long-standing obstruction are all complications of urinary calculi.

The most dangerous aspect of stone disease is a combination of obstruction and infection within the urinary tract, which

requires immediate surgical intervention. Developing infection adjacent to the highly vascular renal parenchyma is associated with a high risk of progressive sepsis and patient death.

Treatment options for non-complicated disease include: open nephrolithotomy (very rare, only for large calculi), percutaneous nephrolithotomy, extracorporeal shock wave lithotripsy and observation with adequate hydration and analgesia.

Without proper medical treatment, urinary stones recur in 10% of patients within 1 year and 50% at 10 years.

Abdominal colic

Abdominal colic is described as a severe, paroxysmal pain within the abdominal cavity, most commonly caused by focal or diffuse pathology within the alimentary tract. It is related to a severe intestinal spasm and/or bowel obstruction, which can be partial or complete. Common causes of obstruction in patients with colicky pain include: intussusception, volvulus, formation of intraperitoneal adhesions, inflammatory changes within the bowel wall or focal wall pathology, as polyps or Meckel's diverticulum and intraluminal causes, like swallowed foreign bodies or gallstone ileus. Persistent bowel obstruction quickly leads to development of more constant pain and clinical signs of acute abdomen.

Infants

Infant colic is a common condition, affecting 10–20% of all babies. It is described as episodes of persistent crying in a healthy baby, caused most likely by severe abdom-

inal pain (swollen, hard or tender abdomen with abnormal bowel peristalsis). The exact pathophysiology is unknown, but possible causes or contributing factors include swallowing large amount of air during feeding, immaturity of the digestive system, food intolerance or emotional factors.

It is more common in boys than girls. Clinical symptoms usually appear in the third or fourth week of life, with most severe episodes around 3 months of age. It should spontaneously settle by the age of 6 months.

Conclusions

Severe paroxysmal pain, caused by biliary, renal or abdominal colic, is a common cause of emergency admission in hospitals worldwide. These patients often require intravenous analgesia for pain management and adequate hydration. Urgent radiological investigations should be performed to establish the cause of the acute pain and initiate treatment. Different imaging modalities should be tailored to patients' complaints and clinical presentation to establish a diagnosis and monitor potential complications. [BJHM](#)

Conflict of interest: none.

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KEY POINTS

- Patients with clinical symptoms of acute colic require adequate pain control and imaging investigations to establish the correct diagnosis and proper medical treatment.
- Ultrasound examination remains the first-line radiological investigation in patients with biliary colic, while computed tomography and magnetic resonance imaging are reserved for patients with developing complications or unclear ultrasound results.
- Computed tomography of the kidney, ureter and bladder (KUB) is the examination of choice in diagnosis of renal colic. Calculi visible on plain abdominal radiograph can be followed on consecutive X-rays to avoid further computed tomography scans with a high radiation dose.
- Undiagnosed and untreated biliary, renal or abdominal colic can lead to serious complications, development of general sepsis and death.