The role of multi-detector computed tomography in imaging hernias

Clinical presentation of a hernia is often non-specific or atypical and in these circumstances diagnosis and management decisions can be aided by imaging. This review contains diagrammatic illustrations, explanations and computed tomography examples of the different types of external, internal and diaphragmatic hernias.

Hernias are broadly classified into external, internal and diaphragmatic hernias. Imaging is helpful when clinical diagnosis is not straightforward, or to aid surgical decision making. Historically plain radiographs and fluoroscopy were the main forms of imaging, but these have been superseded by multi-detector computed tomography which has a number of advantages. This article provides an up-to-date visual portrayal of the role of multi-detector computed tomography in imaging hernias.

Advantages of multi-detector computed tomography in hernia imaging

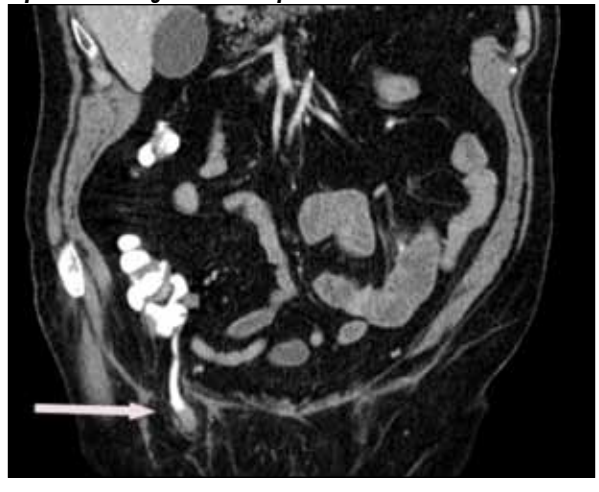
Computed tomography is now the imaging modality of choice for the investigation of abdominal hernias because of its speed, availability and multi-planar formatting capabilities. Multi-planar reformatting should always be performed as it allows better hernia detection and delineation of relationships with other structures and anatomical spaces (Aguirre et al, 2005). There are a number of clinical scenarios where hernias merit multi-detector computed tomography investigation, including diagnostically challenging cases where presentation is atypical, in obese patients or patients with surgical scars (Aguirre et al, 2004), or in internal and diaphragmatic hernias where the clinical signs are usually non-specific (Mathieu and Luciani, 2004). In these circumstances multi-detector computed tomography confirms the diagnosis, differentiates hernias from other abdominal masses, and accurately delineates a hernia's anatomical site, size and sac contents (*Figure 1*).

Multi-detector computed tomography also plays a critical role in hernias presenting acutely with complications such as bowel obstruction and strangulation. In these surgical emergencies, prompt and accurate diagnosis is essential to enable timely intervention and preservation of bowel viability. Because of the exquisite level of anatomical detail achieved with modern-day scanners subtle signs of complication, such as stranding in the mesenteric fat, mesenteric vessel engorgement and bowel wall thickening, are readily detectable (Aguirre et al, 2004). Concomitant intra-abdominal pathology, which may influence clinical management decisions, is also demonstrated (*Figures 2a* and *b*).

Multi-detector computed tomography assessment should be performed with oral contrast or water to visualize bowel loops, and intravenous contrast to assess the vascular supply (Aguirre et al, 2005). Fast image acquisition with three-dimensional data sets and multi-planar reformat capability allows depiction of hernia characteristics and their relationships to surrounding structures in formats facilitating communication and surgical planning with non-radiological clinicians.

Ultrasound is the first-line imaging modality for groin hernias and ventral defects as it is effective in their diagnosis, inexpensive, quick and portable. It is performed in real time and allows dynamic assessment with easy change in patient position and use of techniques to promote hernia detection such as coughing and the valsalva manoeuvre (Bradley et al, 2006). Ultrasound does not involve radiation, while the effective radiation dose from a computed tomography of the abdomen and pelvis is about 8 mSv which is equivalent

Figure 1. Coronal computed tomography with oral and intravenous contrast confirms an appendix (arrow) in a right inguinal hernia in a patient with right iliac fossa pain.



Dr Isabel Laurence *is Final Year Radiology Registrar and* **Dr Eleanor Ngan-Soo** *is Second Year Radiology Registrar, Severn Deanery Training Scheme, Frenchay Hospital, North Bristol NHS Trust, Bristol BS16 1LE and* **Dr Sanjay Gandhi** *is Consultant Radiologist, Frenchay Hospital, North Bristol NHS Trust and Honorary Senior Clinical Lecturer, University of Bristol*

Correspondence to: Dr I Laurence

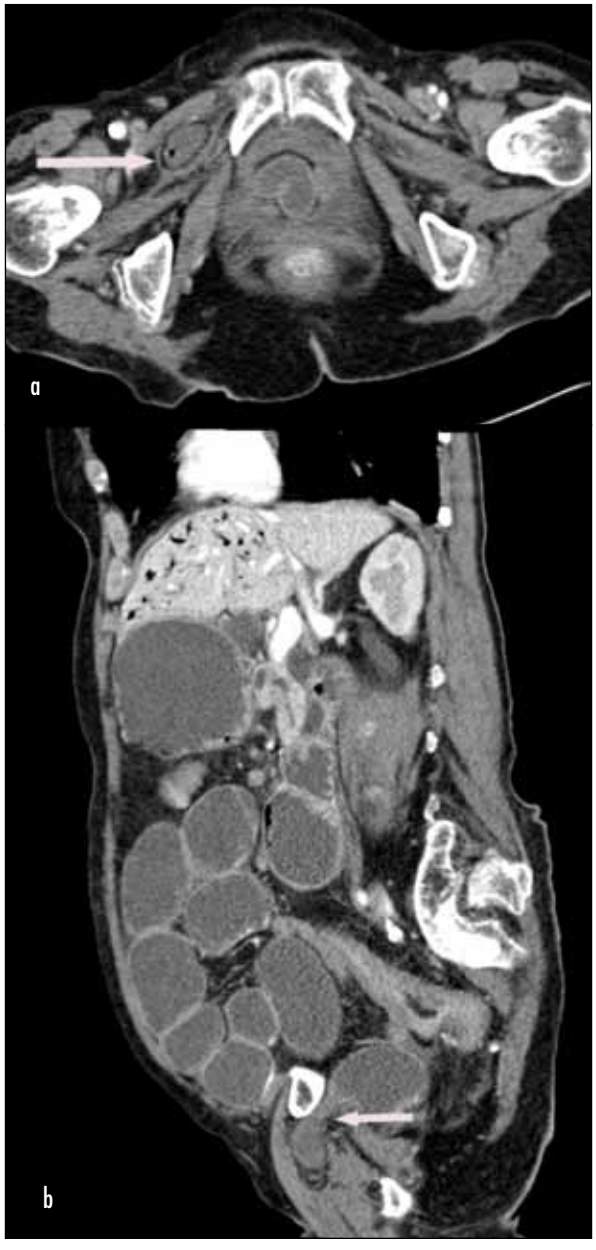


Figure 2. a. Axial and (b) sagittal computed tomography with intravenous contrast demonstrates a right obturator hernia (arrows) resulting in small bowel obstruction. On the sagittal image gas in the intrahepatic portal veins (poor prognostic sign) is demonstrated and the wall of the bowel in the hernia sac does not enhance consistent with ischaemia.

to around 3 years' background radiation (Farr and Allisy-Roberts, 2005). Ultrasound cannot compete with multi-detector computed tomography in the detection and characterization of internal or diaphragmatic hernias but deserves mention in any review of hernia imaging, although it will not be covered in detail in this article.

External hernias

External abdominal wall hernias are the most common hernias, occurring through a congenital or acquired abdominal wall muscle defect. Manoeuvres to increase intra-abdominal pressure to enhance subtle external hernias can be used (Aguirre et al, 2004, 2005).

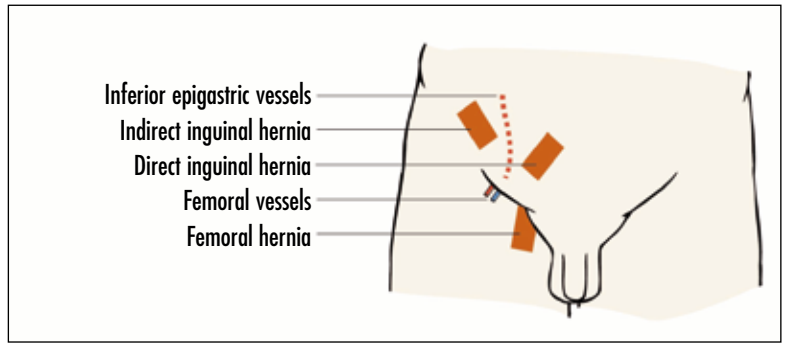


Figure 3. Relationship between hernias of the groin and vascular structures.

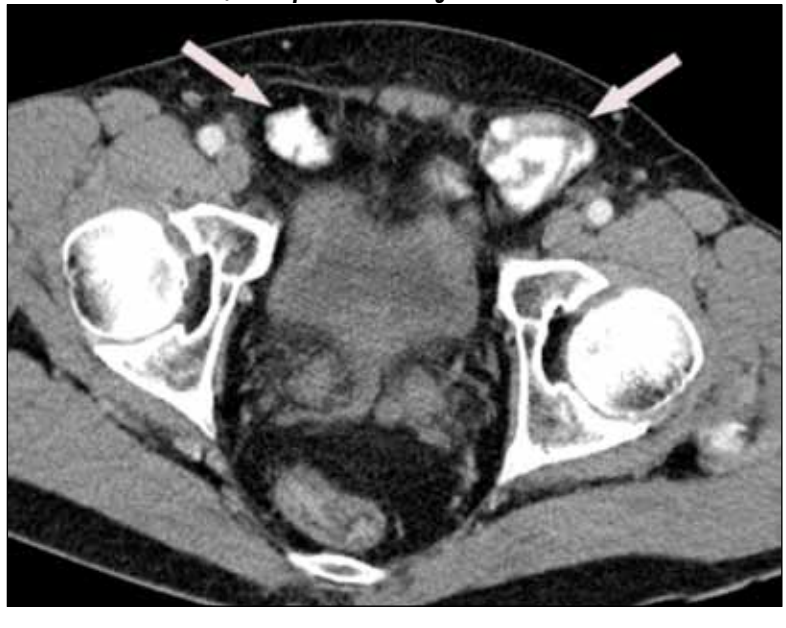
Groin

There are two types of groin hernia (*Figure 3*), inguinal and femoral:

Inguinal hernias

These emerge above and medial to the pubic tubercle and are classified depending on the relationship of the hernia neck to the epigastric vessels. They are either direct or indirect. Direct inguinal hernias lie medial to the epigastric vessels, and are usually secondary to an acquired transversalis fascia weakness. These are frequently bilateral and most common in middle-aged men. Strangulation is a rare complication because of the wide defect (*Figure 4*). Indirect hernias occur via a patent processus vaginalis, protrude lateral to the epigastric vessels and usually contain omentum and small bowel. They are more common in men and account for nearly all paediatric inguinal hernias (*Figure 5*).

Figure 4. Axial computed tomography with oral and intravenous contrast. The arrows demonstrate the bilateral, uncomplicated direct inguinal hernias.



Femoral hernia

The less common femoral hernia lies below the inguinal ligament, lateral to the femoral vessels. They are more common in elderly women and bowel strangulation is a common complication.

Ventral defects

This group of hernias (*Figure 6*) occur via a midline or lateral abdominal wall defect.

Figure 5. Topogram of a computed tomography scan performed for abdominal pain and vomiting in an elderly gentleman. A large right inguinal hernia is demonstrated (arrow). Large and small bowel obstruction caused by a splenic flexure tumour rather than a complication of the hernia was demonstrated.

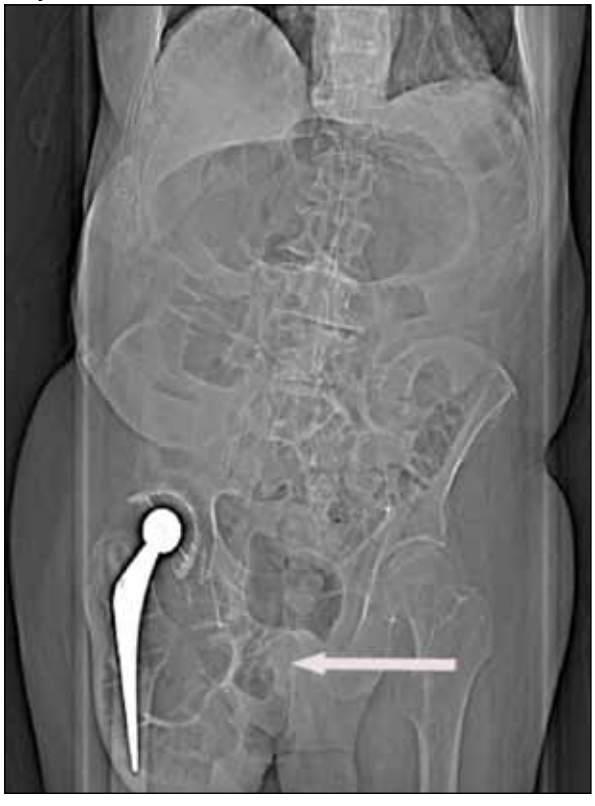
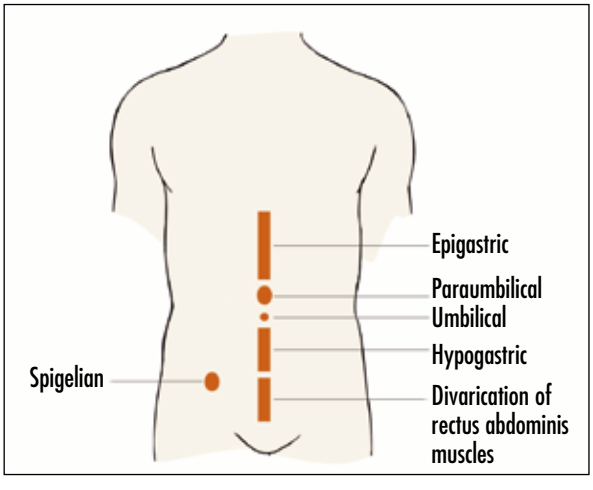


Figure 6. Relationship of ventral hernias to the umbilicus and midline.



Paraumbilical hernias

These protrude through the linea alba, lying adjacent to the umbilicus. They are acquired, often in obese and pregnant patients, usually secondary to diastasis of rectus abdominis (*Figure 7*).

Umbilical hernias

Umbilical hernias are congenital hernias via a defect created by the umbilical cord. They contain bowel or just intra-abdominal fat, both of which can become incarcerated or strangulated.

Epigastric and hypogastric hernias

These are uncommon linea alba herniations, occurring above and below the umbilicus respectively.

Spigelian hernias

Spigelian hernias (*Figure 8*) are characteristically a full-thickness herniation through the linea semilunaris mus-

Figure 7. Axial computed tomography with oral and intravenous contrast showing an uncomplicated paraumbilical hernia (arrow) in a female.

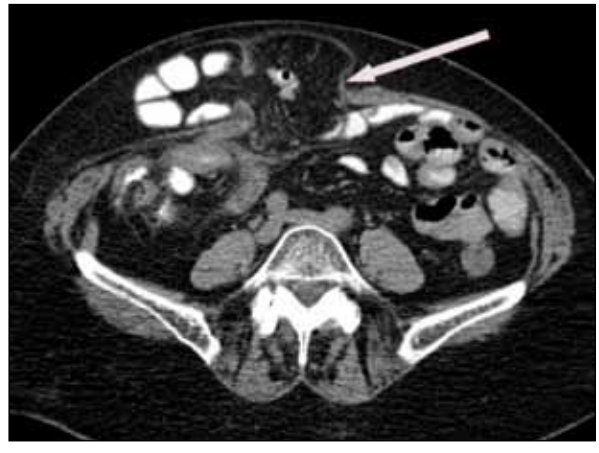
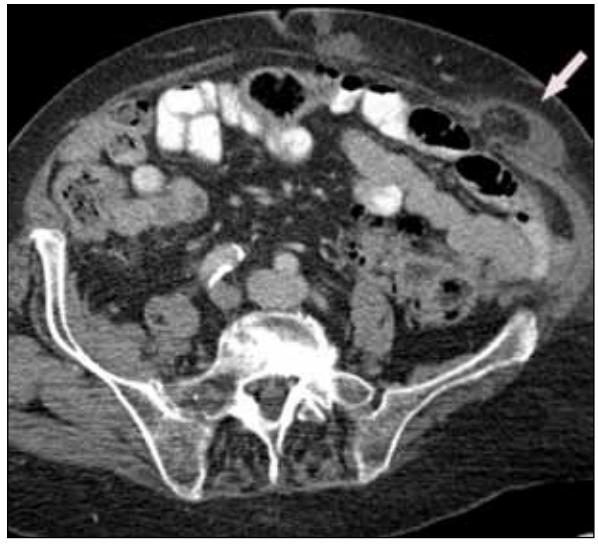


Figure 8. Axial computed tomography with oral and intravenous contrast reveals a fat- and fluid-containing Spigelian hernia (arrow).



culature, often secondary to an acquired weakness of the rectus aponeurosis. Strangulation and incarceration commonly occur.

Lumbar hernia

A lumbar hernia occurs through the lumbar muscles or posterior fascia, between the 12th rib and iliac crest.

Incisional hernia

Incisional hernias are late complications of abdominal surgery, arising most commonly from vertical incisions (*Figures 9* and *10*). A parastomal hernia is a common variant occurring alongside a stoma.

Figure 9. Axial computed tomography with oral and intravenous contrast demonstrating a small, incisional hernia through the right rectus abdominus muscle (arrow).

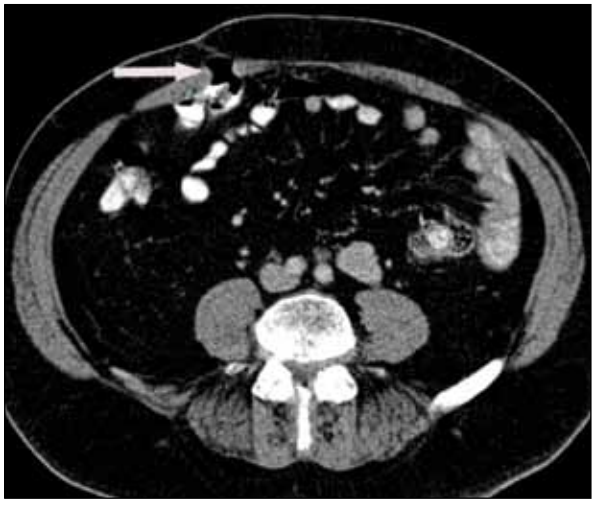
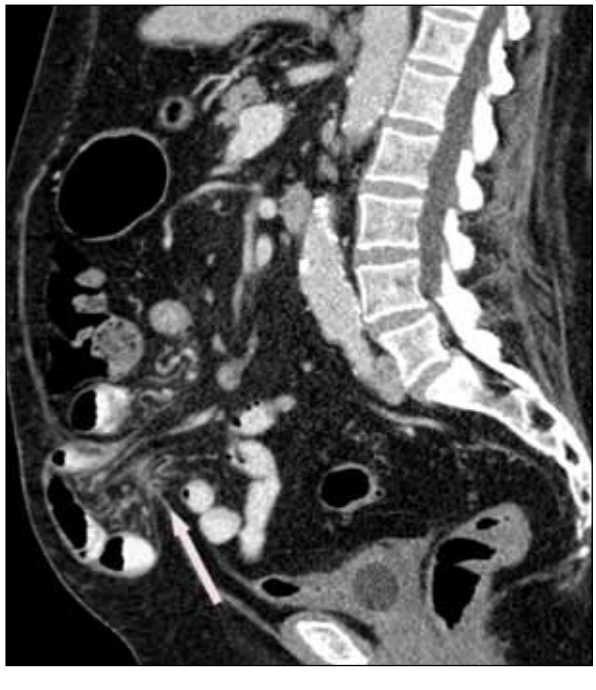


Figure 10. Sagittal computed tomography with oral and intravenous contrast. The arrow demonstrates a ventral incisional hernia (different patient from* Figure 9*).



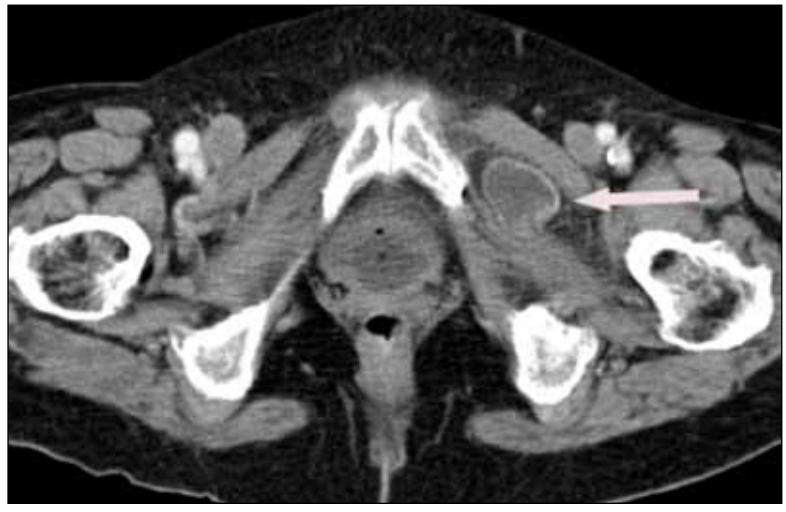


***Figure 11. Axial computed tomography with oral and intravenous contrast demonstrating uncomplicated left obturator hernia. Note the enhancement of bowel which was absent in* Figure 2.**

Obturator hernia

Obturator hernias are rare herniations through the obturator foramen, extending between the pectineal and obturator muscles. They are more common in elderly women and carry a high risk of incarceration (*Figure 11*).

Other external hernia

These are rare and include: Littre hernias, which contains a Meckel's diverticulum; interparietal hernias, located in the fascial planes between abdominal wall muscles; sciatic hernias occurring through the greater or lesser sciatic foramen; or perineal hernias, which tend to occur in older women via an acquired pelvic floor weakness and lie adjacent to the anus, labia majora or within the gluteal region (Wechsler et al, 1989; Zarvin et al, 1995; Aguirre et al, 2004).

Internal hernias

These congenital or acquired hernias occur through a mesenteric or peritoneal defect, and are not directly visualized (*Figure 12*). Instead, internal hernias are suspected by crowding and abnormal positioning of bowel loops, and encapsulated, engorged vessels which have a swirled appearance within the hernia sac (Mathieu and Luciani, 2004) (*Figure 13*). The incidence of internal hernias is increasing with the increase in laparoscopic surgery and other relatively new procedures such as gastric bypass surgery (Martin et al, 2009).

Diaphragmatic hernia

These occur through a diaphragmatic weakness or abnormal opening allowing abdominal cavity contents to lie within the mediastinum (*Figure 14*).

Congenital diaphragmatic hernias

Bochdalek hernias protrude through a postero-lateral diaphragm defect. They are classically located on the left, and contain fat, omentum and occasionally a kidney.

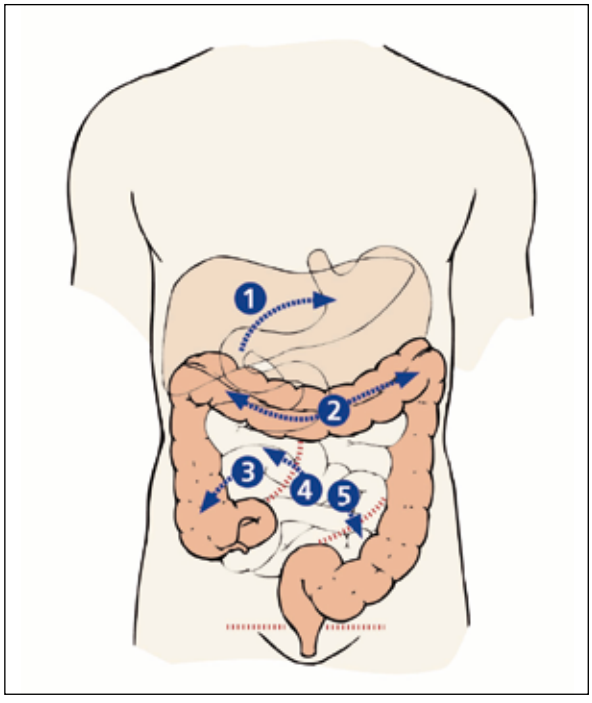


Figure 12. Internal hernias. 1: through the foramen of Winslow; 2: right and left paraduodenal; 3: retrocaecal; 4: transmesenteric; 5: intersigmoid.

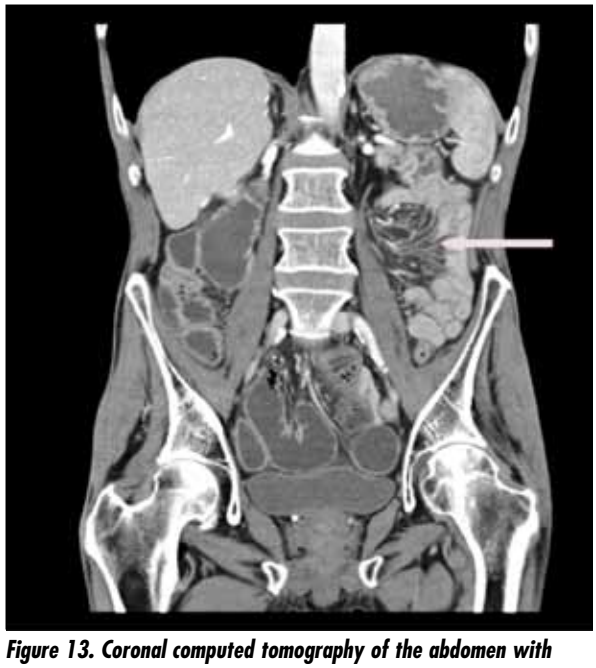


Figure 13. Coronal computed tomography of the abdomen with intravenous contrast demonstrating herniation of small bowel into the lesser sac (confirmed at surgery). The swirled, engorged vessels (arrow) entering the hernia sac are easily appreciated.

Morgagni hernias usually occur on the right via an anterior-medial defect, and contain fat, omentum and sometimes bowel (Pineda et al, 2007).

Acquired diaphragmatic hernias

These most commonly occur on the left as sequelae to blunt trauma rather than penetrating injuries.

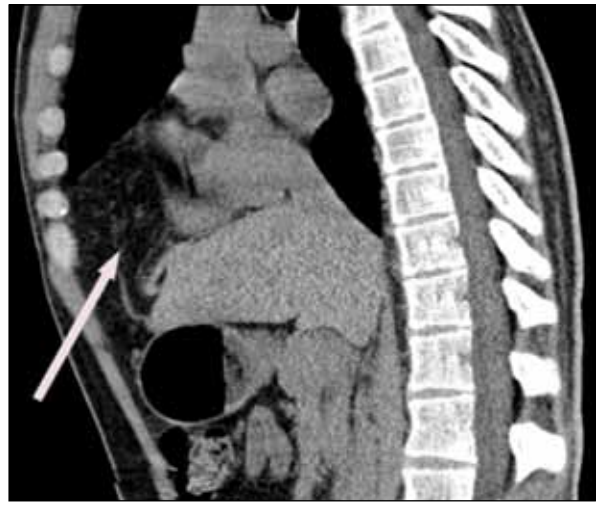


Figure 14. Sagittal computed tomography of the thorax in a 22-year-old man with intermittent abdominal pain and vomiting confirms a previously undiagnosed Morgagni hernia (arrow) containing omental fat.

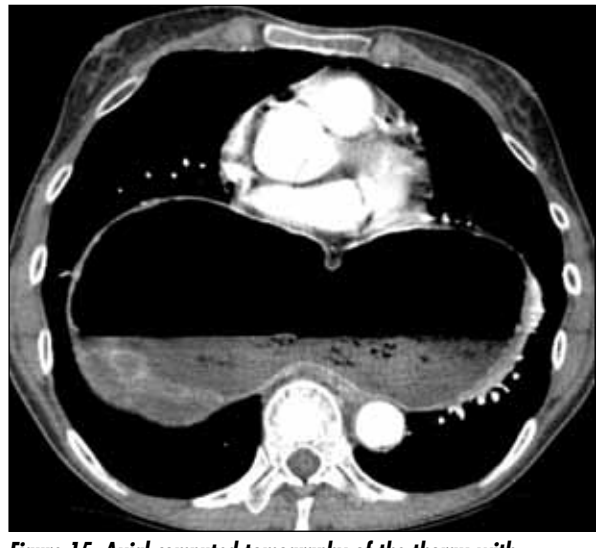


Figure 15. Axial computed tomography of the thorax with intravenous contrast demonstrating a large hiatus hernia.

Hiatus hernia

The vast majority are sliding hernias, where the gastro-oesophageal junction slides above the diaphragmatic hiatus with a variable portion of stomach (*Figure 15*). A rolling hernia contains a portion of stomach within the thorax while the gastro-oesophageal junction remains intra-abdominal (Abbara et al, 2003).

Conclusions

Multi-detector computed tomography with multi-planar reformatting has become an invaluable tool in the assessment of those abdominal wall hernias that are diagnostically challenging and their complications. BJHM

The authors would like to thank their radiological colleagues at North Bristol Trust for their help with obtaining the images used.
Conflict of interest: none.

Abbara S, Kalan M, Lewicki A (2003) Intrathoracic stomach revisited. *AJR* **181:** 403–14
Aguirre D, Casola G, Sirlin C (2004) Abdominal wall hernias: MDCT findings. *AJR* **183:** 681–90
Aguirre D, Santosa A, Casola G, Sirlin C (2005) Abdominal wall hernias: imaging features, complications, and diagnostic pitfalls at multi-detector row CT. *Radiographics* **25:** 1501–20
Bradley M, Morgan J, Pentlow B, Roe A (2006) The positive predictive value of diagnostic ultrasound for occult herniae. *Ann R Coll Surg Engl* **88**(2): 165–7
Farr R, Allisy-Roberts P (2005) *Physics for Medical Imaging.* Saunders, London
Martin L, Merkle E, Thompson W (2009) Review of internal hernias: radiographic and clinical findings. *AJR* **186:** 703–17
Mathieu D, Luciani A (2004) Internal abdominal herniations. *AJR* **183:** 397–404
Pineda V, Andreu J, Caceres J, Merino X, Varona D, Dominguez-Oronoz R (2007) Lesions of the cardiophrenic space: findings at cross-sectional imaging. *Radiographics* **27:** 19–32
Wechsler R, Kurtz A, Needleman L et al (1989) Cross sectional imaging of abdominal wall hernias. *AJR* **153:** 517–21
Zarvin N, Lee F, Yandow D, Unger J (1995) Abdominal hernias: CT findings. *AJR* **164:** 1391–5

KEY POINTS

- Multi-detector computed tomography with multi-planar reformatting has become an invaluable tool in the assessment of those abdominal wall hernias that are diagnostically challenging and their complications.
- Multi-detector computed tomography confirms the diagnosis, differentiates hernias from other abdominal masses, and accurately delineates a hernia's anatomical site, size and sac contents.
- Concomitant intra-abdominal pathology, which may influence clinical management decisions, is demonstrated.
- Fast image acquisition with three-dimensional data sets and multi-planar reformat capability allows depiction of hernia characteristics and their relationships to surrounding structures in formats facilitating communication and surgical planning with non-radiological clinicians.