11 Direct Inguinal Hernia

Joseph R. Imbus and Jacob A. Greenberg

Introduction and Relevant Anatomy

In the seventeenth and eighteenth centuries, anatomists and surgeons made great strides in understanding inguinal hernias. Lorenz Heister (1683–1758) is credited with differentiating the direct from indirect inguinal hernia during this era of anatomic discovery. Accounting for 15% of inguinal hernias, direct inguinal hernias represent a protrusion of parietal peritoneum and potentially abdominal viscera through an acquired weakening of the transversalis fascia in the posterior wall of the inguinal canal. These abdominal wall defects are more common in men compared to women, increase in incidence with increasing patient age, and are less likely to incarcerate or strangulate compared to indirect inguinal hernias. Uncommonly, direct inguinal hernias can develop concurrently with an indirect inguinal hernia. When this occurs, hernia sacs are present on both sides of the inferior epigastric vessels and thus referred to collectively as a "pantaloon hernia." Franz Hesselbach (1759–1816) described the now eponymous anatomic triangle which defines the location of direct inguinal hernias, that is, the region bound medially by the lateral edge of the rectus abdominus, inferiorly by the inguinal ligament, and superolaterally by the inferior epigastric vessels (Fig. 11.1). A sound understanding of inguinal anatomy is essential for clinicians evaluating inguinal hernias, and the relationship to the inferior epigastric vessels ultimately defines direct versus indirect hernias. A direct inguinal hernia

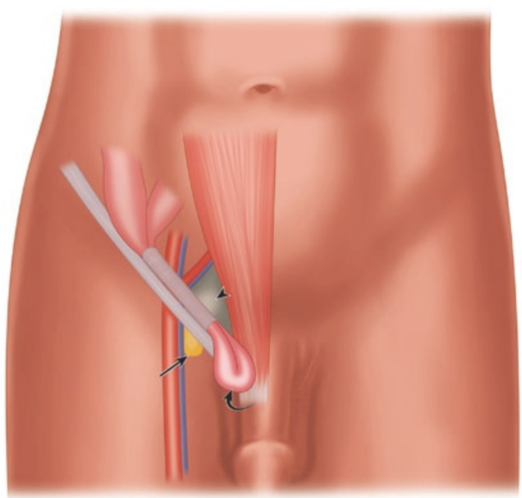

Fig. 11.1 Hesselbach's triangle (arrowhead); femoral ring (straight arrow); indirect inguinal hernia (curved arrow)

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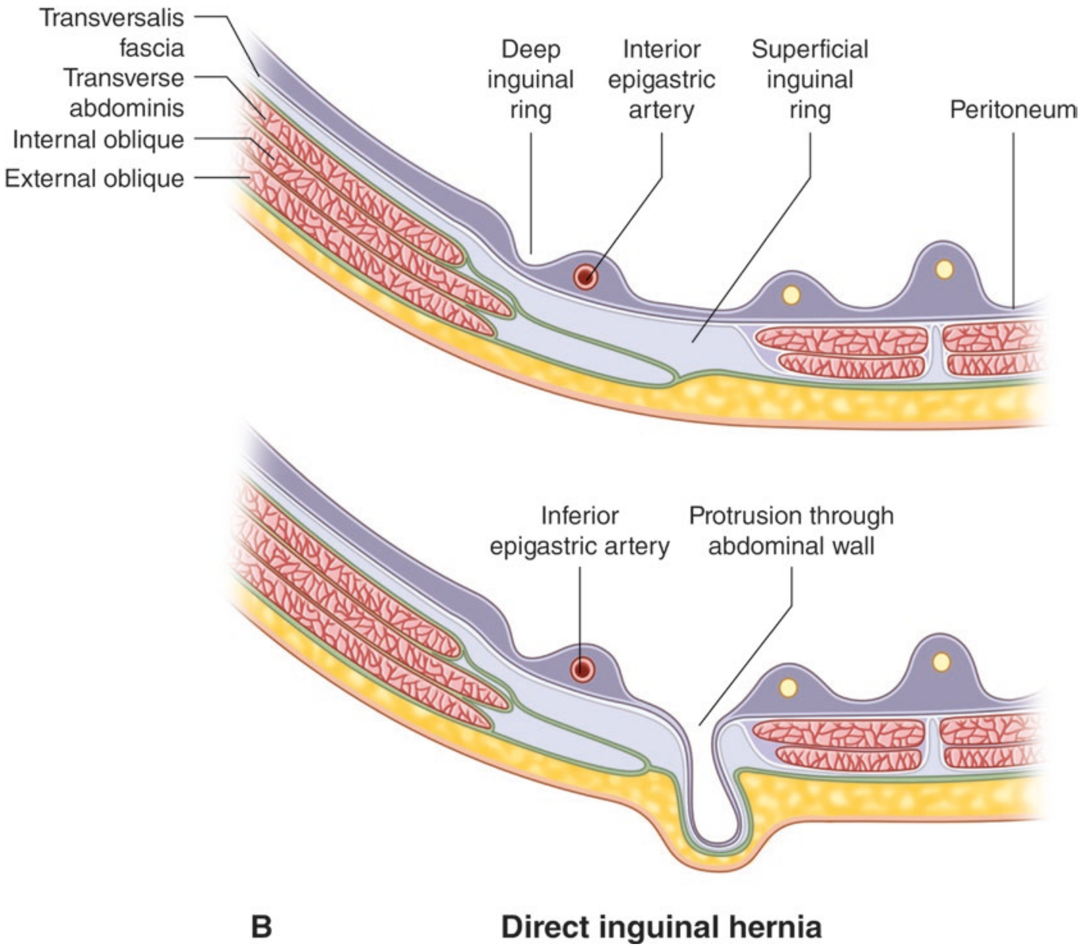

Fig. 11.2 A direct inguinal hernia protrudes medial to the inferior epigastric artery, and may extend into the superficial ring upon Valsalva

protrudes medial to the inferior epigastric artery and may extend into the superficial ring upon Valsalva (Fig. 11.2).

Role of Imaging for Direct Inguinal Hernia Diagnosis

Inguinal hernias commonly present as a painful bulge in the groin and a thorough history and physical exam are typically sufficient for diagnosis. Thus, the majority of patients should not require any imaging modality as part of their workup. However, patient and hernia factors including obesity and small hernia size can make diagnosis difficult without confirmatory imaging. Furthermore, the accuracy of physical examination in discriminating between direct and indirect inguinal hernias is debated in the literature, though is frequently not clinically relevant as both types of hernias should be routinely repaired via an open or minimally invasive approach. Preoperative differentiation of direct inguinal hernia from alternate pathologies, as well as definition of hernia sac contents, can be useful for surgical planning. Given the dynamic nature of inguinal hernias, ultrasonography (US) is the preferred imaging modality to evaluate inguinal hernias, but multidetector computed tomography (MDCT) and magnetic resonance imaging (MRI) are also potentially useful. In this chapter, we review US, MDCT, and MRI imaging for direct inguinal hernias, as well as postoperative imaging considerations.

Dynamic Ultrasound

Equipment and Technique

A high-frequency (≥10 MHz), long linear transducer operated by a skilled sonographer is recommended. For obese patients, a low-frequency curvilinear transducer (7–9 MHz) can improve imaging. Panoramic mode, if available, is useful to capture a more comprehensive anatomic view. Color Doppler capability aids in assessment of bowel perfusion for incarcerated hernias. Both still images and recorded video loops should be captured. The sonographer should use light pressure on the skin during imaging acquisition to avoid anatomic distortion. Compression can be intentionally used to assess reducibility and tenderness. Radiologist supervision is recommended to ensure quality and orientation of US imaging.

No patient preparation is required prior to inguinal US. The patient should first be imaged in a relaxed, supine position. Additional evaluation in the upright position should be performed to further evaluate any findings or to search for findings if supine examination is unremarkable. Several patient maneuvers to increase intra-abdominal pressure can be used to create dynamic images. These include the Valsalva maneuver—forced expiration against a closed glottis (i.e., “Blow on your thumb like a trumpet.”), forceful cough, and raising one’s head and shoulders off the bed from a resting position. Dynamic evaluation can reveal hernias otherwise occult at rest. In addition, hernias visible at rest generally become larger with Valsalva; a lack of dynamic movement may suggest incarceration.

Placement of the transducer transversely near the midpoint of the pubic tubercle and anterior superior iliac spine guides the identification of the key anatomic landmark of interest—the inferior epigastric artery. This technique identifies the origin of the inferior epigastric artery emanating from the external iliac artery. At this point, the inferior epigastric artery lies just medial to the deep inguinal ring. The inferior epigastric artery can also be identified with US reliably on the undersurface of the rectus abdominis midway between the pubic tubercle and umbilicus, and then traced down to its origin. At the origin, the transducer should be rotated such that images are obtained in planes parallel (long-axis) and perpendicular (short-axis) to the inguinal canal (Fig. 11.3).

Reporting

Radiologists should be systematic, consistent, and thorough in reporting dynamic US findings. Positive and negative findings should be reported in not only the direct hernia region but also the indirect and femoral regions of the patient. Synoptic reporting is encouraged to aid readability, interpretation, and use of reports for surgical planning and research purposes. Important elements to report include laterality, patient position and specific dynamic components utilized, presence/absence of hernia, hernia and hernia neck sizes, hernia contents, hernia reducibility, tenderness, and alternate pathology.

Interpretation of Imaging

Familiarity with the normal anatomic adynamic and dynamic long-axis and short-axis views of the inguinal region is useful for reference. Figure 11.4 shows normal male right groin anatomy in the long axis at rest. In this orientation, the male cord appears as a linear bundle of structures with variable echogenicity, and color Doppler can help confirm the cord vasculature. Based on body habitus, a variable amount of expected adiposity is observed enveloping the cord structures. Figure 11.5 shows normal left groin anatomy in the short-axis (anatomic sagittal view). Figure 11.6 shows the appearance of a right-sided direct inguinal hernia on US before and during Valsalva in both the long-axis and short-axis views.

Similarly, Fig. 11.7 shows a direct inguinal hernia during Valsalva in both axes, and annotated overlays are provided to highlight relevant anatomy. Note that in the short axis, a direct hernia displaces and compresses the spermatic cord anteriorly and laterally.

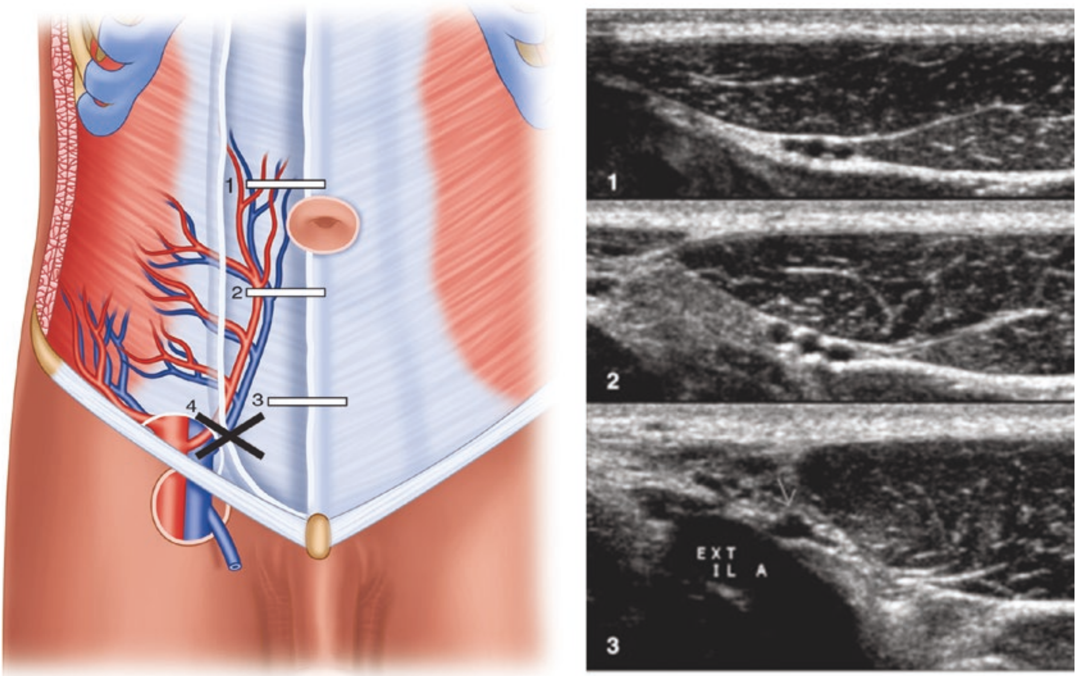

Fig. 11.3 Inferior epigastric vessels (IEVs) are the main landmarks for evaluating inguinal area
Image 1 was obtained in a transverse plane about halfway between the umbilicus and the pubic symphysis. The inferior epigastric artery and its paired veins lie along the midlateral posterior surface of the rectus abdominis muscle. Image 2 was obtained several centimeters inferiorly, and the IEVs lie more laterally. Image 3 was obtained at a level where the IEVs (arrow) lie at the edge of the rectus muscle. This is the level at which most spigelian hernias occur. Once the origin of the inferior epigastric artery is identified, the transducer should be rotated into planes that are parallel (see line 4 on the drawing) and perpendicular (see image 3) to the inguinal canal—long-axis and short-axis views
Modified from: Diagnostic Ultrasound. Dynamic Ultrasound of Hernias of the Groin and Anterior Abdominal Wall

In general, a direct inguinal hernia will bulge towards the US transducer on examination during Valsalva. Video 11.1 is an example of ultrasound use in hernia evaluation.

"Posterior inguinal wall insufficiency" or "conjoint tendon insufficiency" is an entity identifiable with US and considered a precursor to direct inguinal hernia. The conjoint tendon is comprised of the aponeuroses of the internal oblique and transversus abdominus muscles, with underlying transversalis fascia. Thinning and anterior bulging of the conjoint often occurs bilaterally but can cause symptoms unilaterally and/or progress to direct inguinal hernia if an overt tear or severe thinning occurs. This entity is often indistinguishable from direct inguinal hernia on the short-axis, but long-axis evaluation will show "posterior inguinal wall insufficiency" take on a semi-circular shape whereas a direct inguinal hernia protrudes inferiorly with a finger-like projection. This difference is illustrated in Fig. 11.8.

Given the poor negative predictive value of US for inguinal hernias, a negative study in a symptomatic patient warrants the pursuit of additional imaging modalities.

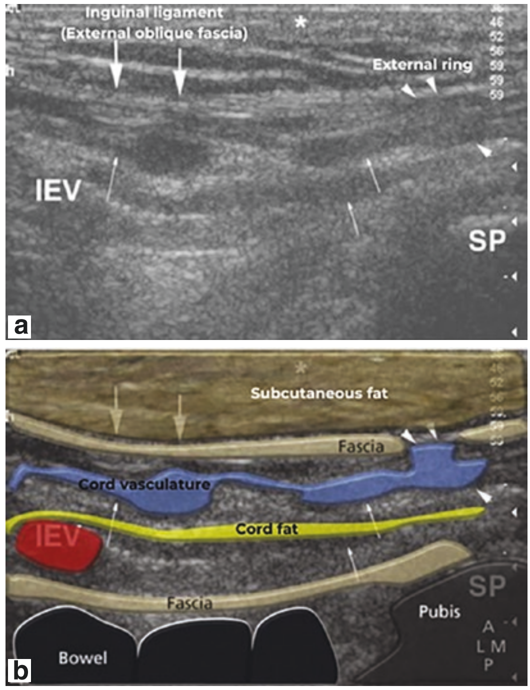

Fig. 11.4 Normal right inguinal canal, transverse sonogram. The IEVs lie medial to the internal ring. The thick echogenic inguinal ligament (large arrows) lies anteriorly, deep to the subcutaneous fat (*). Multiple tubular structures are seen (small arrows) passing medially towards the symphysis pubis (SP) and passing through the external ring where a defect (arrowheads) in the inguinal ligament can be visualized. With permission from: Practical Musculoskeletal Ultrasound [Philip Robinson]. Disorders of the Groin and Hip: Groin Pain

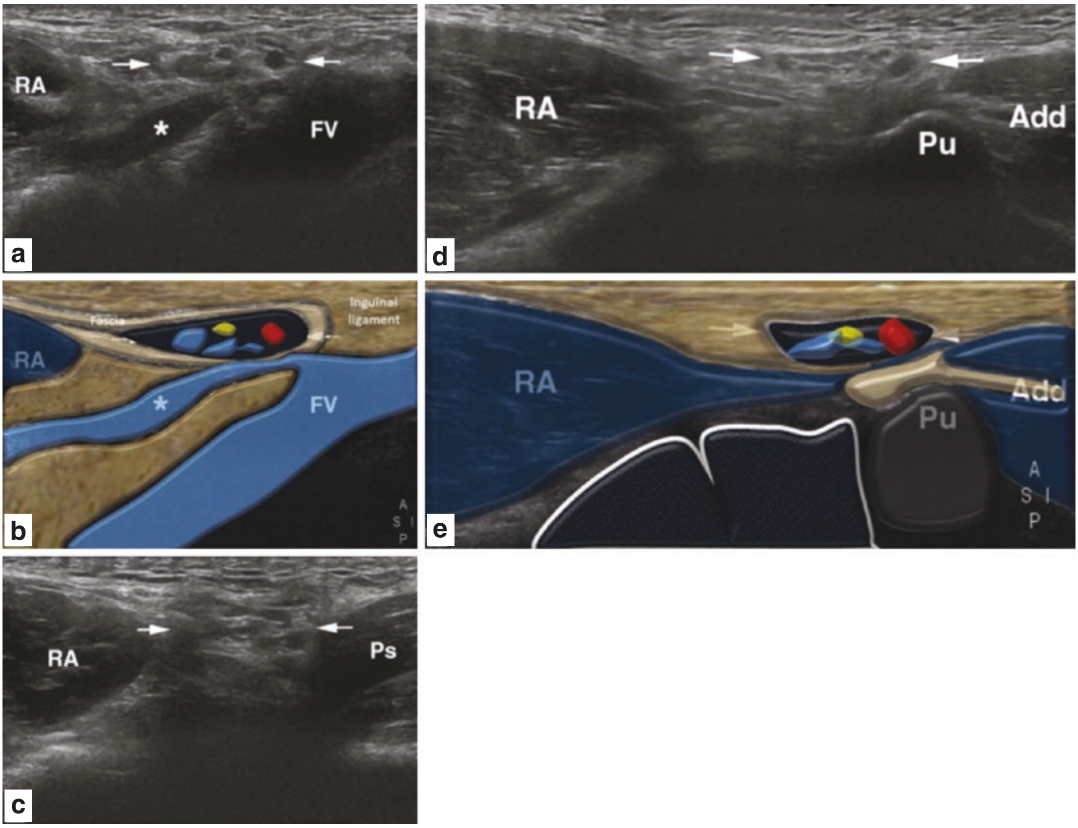

Fig. 11.5 Normal left inguinal canal, sagittal sonograms. (**a**, **b**) Image obtained at the level of the inferior epigastric vein (*) as it arises from the femoral vein (FV). The inguinal canal is seen as an oval-shaped soft tissue area containing multiple tubular structures (arrows) with rectus abdominis (RA) lying superiorly. (**c**) Medial to position in (**a**). (**d**, **e**) Medial to (**c**) at the level of the superficial ring as the contents (arrows) descend over the pubis (Pu) and adductor origin (Add)

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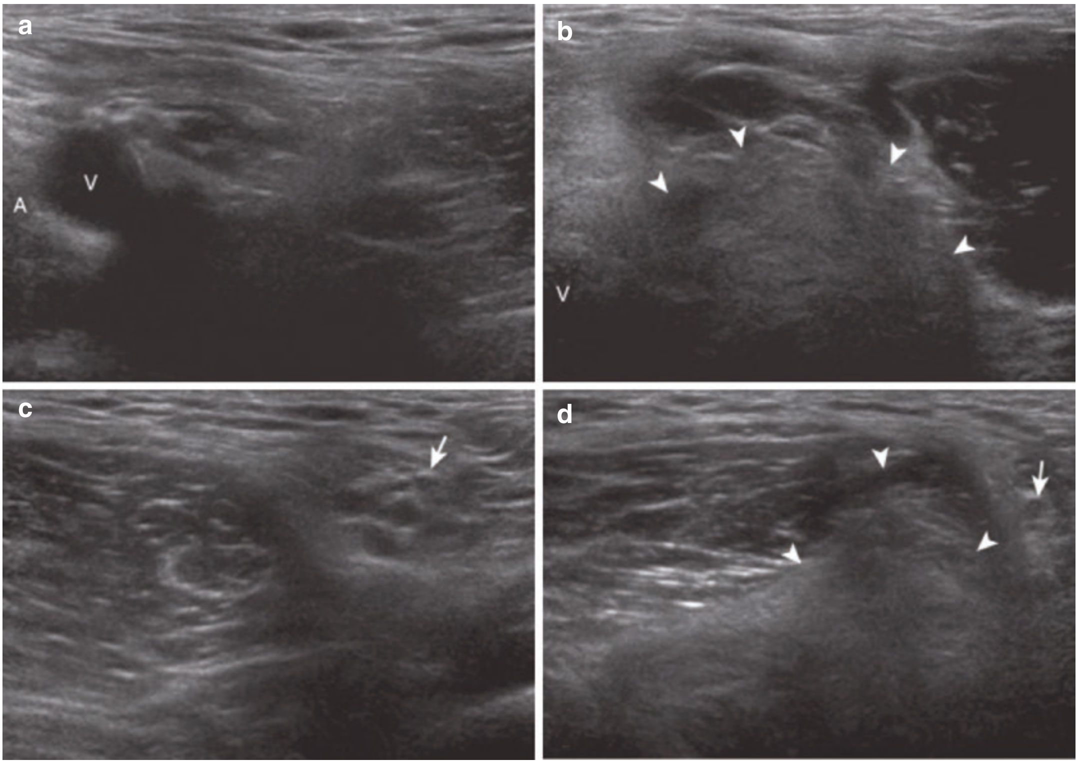

Fig. 11.6 Direct Inguinal Hernia
Ultrasound images parallel to the right inguinal canal (**a**) before and (**b**) during the Valsalva maneuver show abnormal echogenic intra-abdominal contents (arrowheads), which protrude anteriorly, medial to the external iliac vasculature (A and V) (left side of the image is lateral). Ultrasound images in short axis to the right inguinal canal (**c**) before and (**d**) during the Valsalva maneuver show abnormal echogenic intra-abdominal contents (arrowheads), which protrude anteriorly and displace the spermatic cord (arrow)
With permission from: Fundamentals of Musculoskeletal Ultrasound. Hip and Thigh Ultrasound

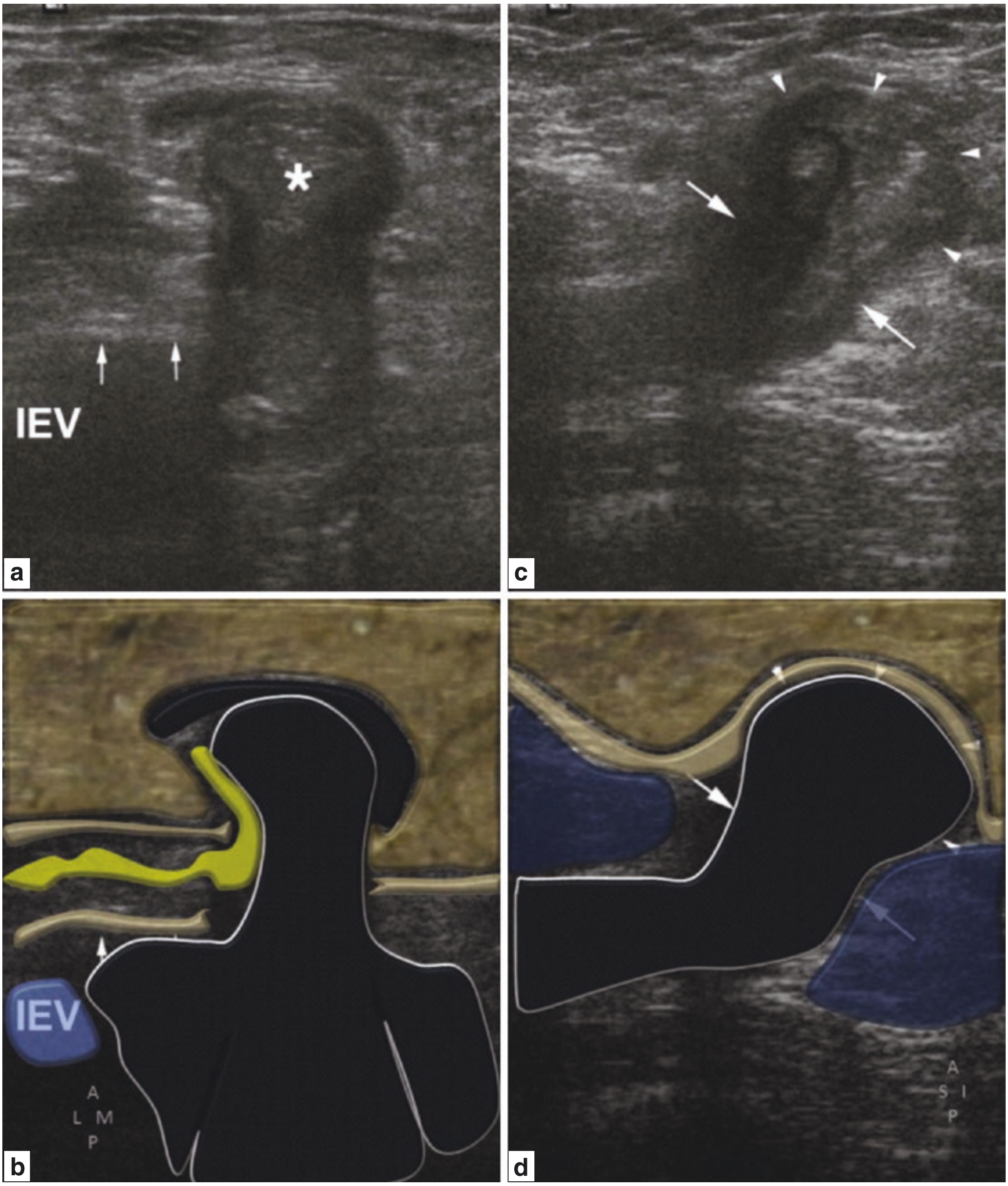

Fig. 11.7 Right direct hernia. (**a**, **b**) Transverse sonogram during straining shows the IEVs and adjacent transversus fascia (arrows) lateral to a hernia of bowel and fat (*) entering through the posterior wall defect. (**c**, **d**) Corresponding sagittal sonogram shows hypoechoic loop of bowel (small arrows) pushing through the posterior wall (large arrows)
With permission from: Practical Musculoskeletal Ultrasound [Philip Robinson]. Disorders of the Groin and Hip: Groin Pain

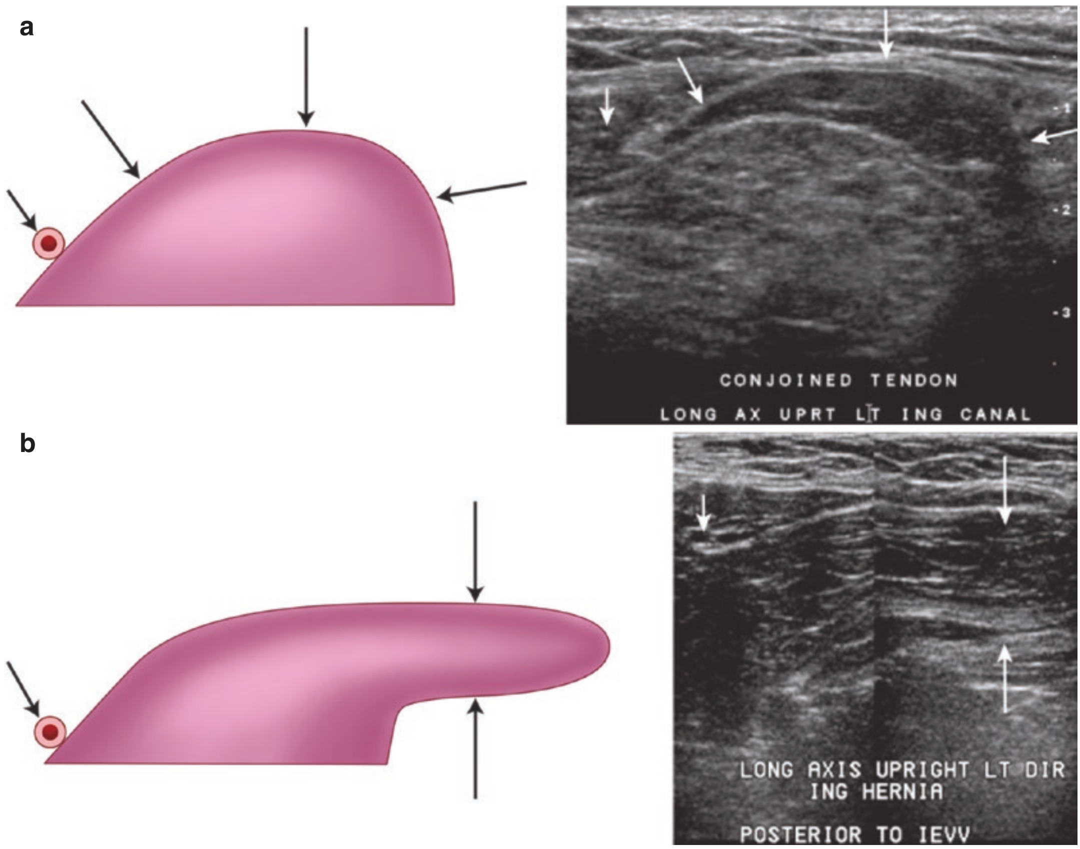

Fig. 11.8 Inguinal wall insufficiency versus direct inguinal hernia
Long-axis views show different appearance of posterior inguinal wall insufficiency and direct inguinal hernia. (**a**) Insufficiency of the posterior inguinal wall (long arrows). Short arrow is inferior epigastric artery. (**b**) Frank direct inguinal hernia extends distally within the inguinal canal in a finger-like projection (long arrows) posterior to the spermatic cord. At the level of the proximal inguinal canal, the distinction is possible only on long-axis views, because insufficiency and frank hernia appear identical on short-axis views obtained proximally. Short arrow is inferior epigastric artery
Modified from: Diagnostic Ultrasound. Dynamic Ultrasound of Hernias of the Groin and Anterior Abdominal Wall

Multidetector Computed Tomography

Technique

MDCT can be used as an alternative or adjunctive imaging modality to dynamic US. MDCT also finds many incidental inguinal hernias. Thin slice reconstruction (≤2.5 mm section) is recommended to optimize coronal and sagittal reformation. When planned, Valsalva maneuvers can be attempted during MDCT to increase detection. Intravenous contrast is necessary to visualize the interior epigastric vessels to differentiate different types of groin hernias. Similarly, oral contrast is used to visualize bowel loops which may be involved. Figure 11.9 shows coronal reformats to visualize a direct inguinal hernia.

Interpretation of Imaging

The Lateral Crescent sign is a radiographic finding to aid identification of direct inguinal hernias on MDCT. Lateral compression and stretching of inguinal canal adipose tissue and structures by an early direct inguinal hernia can manifest as a “moon-like” crescent as illustrated in Fig. 11.10.

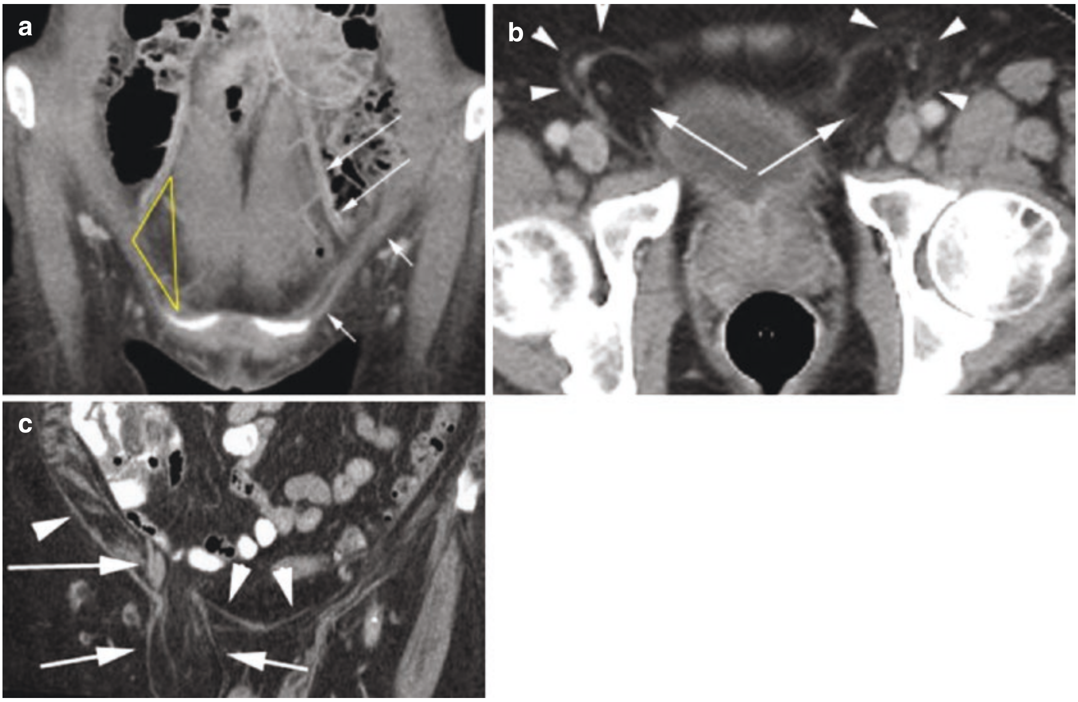

Fig. 11.9 (**a**) CT coronal reformat demonstrates the inguinal ligament (short arrows) and deep inferior epigastric vessels (long arrows). The Hesselbach's triangle is outlined in yellow on the right which superolaterally is marginated by the epigastric vessels, medially by the rectus abdominus, and inferiorly by the inguinal ligament. (**b**) Axial CT demonstrates a lateral crescent sign due to a fat containing direct inguinal hernias (arrows) displacing the contents of the inguinal canal laterally and the fat within it transformed into a crescent (arrowheads). (**c**) CT coronal reformat of a different patient demonstrates a fat containing direct inguinal hernia (short arrow) coursing above the inguinal ligament (arrowheads) with its neck medial to deep inferior epigastric vessels (long arrow)
With permission from: V. Trainer et al./Clinical Radiology 68 (2013) 388–389

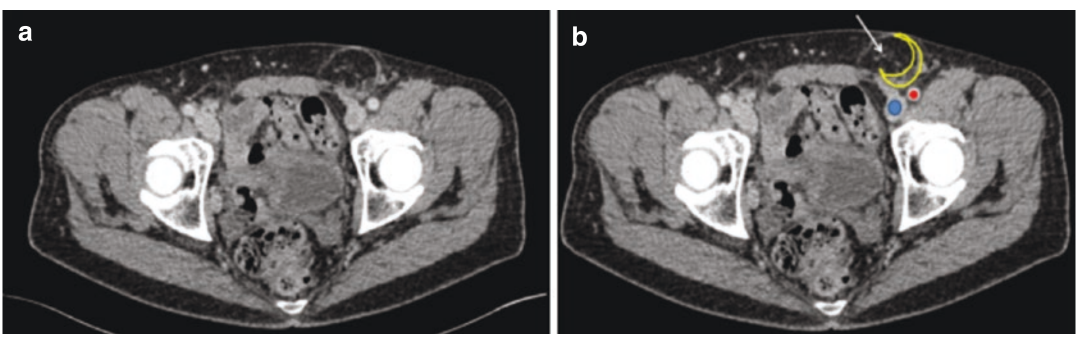

Fig. 11.10 Axial contrast-enhanced CT image (**a**). And color-coded image (**b**). Showing a left direct inguinal hernia. The fat and the other inguinal canal contents (outlined in yellow) are flattened by the herniated fat and omentum (arrow) into a thin lateral "moon-like" crescent. The common femoral artery (red dot) and vein (blue dot) are seen coursing laterally and posteriorly to the hernia
With permission from Schoettle A, Veillon F, Venkatasamy A. The lateral crescent sign. Abdominal Radiology 2018 11;43(11):3195–3196

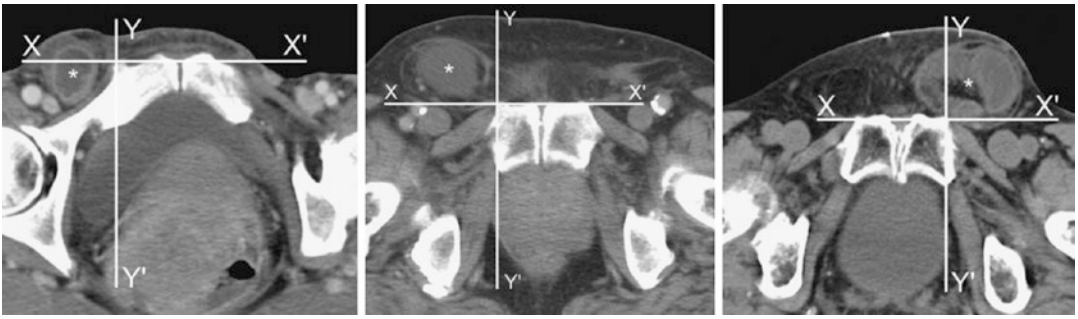

Fig. 11.11 (Left) Contrast-enhanced transverse CT scan at the level of the right pubic tubercle in a 68-year-old female patient. Right femoral hernia (white star), located dorsal to the *X*-axis (*X*–*X*′) and lateral to the *Y*-axis (*Y*–*Y*′), was correctly diagnosed. Middle) Unenhanced transverse CT scan at the level of the right pubic tubercle in an 80-year-old male patient. Right direct inguinal hernia (white star), located ventral to the *X*-axis (*X*–*X*′) and strictly to the *Y*-axis (*Y*–*Y*′), was correctly diagnosed. Right) Unenhanced transverse CT scan at the level of the left pubic tubercle in a 76-year-old male patient. Left indirect inguinal hernia (white star), located ventral to the *X*-axis (*X*–*X*′) and crossing medially the *Y*-axis (*Y*–*Y*′), was correctly diagnosed
With permission from (From: The pubic tubercle: a CT landmark in groin hernia. Delabrousse E, Denue PO, Aubry S, Sarliève P, Mantion GA, Kastler BA—Abdom Imaging—November 1, 2007; 32 (6); 803–6)

The pubic tubercle has been proposed as a landmark to differentiate direct from indirect and femoral hernias, particularly in instances when the inferior epigastric vessels are difficult to distinguish as a landmark. After drawing orthogonal lines on axial MDCT imaging at the level of the pubic tubercle as in Fig. 11.11, dorsal crossing of the *X*-axis suggests femoral origin and medial crossing of the *Y*-axis suggests an indirect inguinal hernia. Although this method has not been validated, it may provide insight for surgical planning in acute scenarios. Video 11.2 shows a CT scan of a patient with a right direct inguinal hernia.

Magnetic Resonance Imaging

MRI is a third-line imaging modality for hernia evaluation. However, compared to MDCT and US, MRI is far more sensitive, specific, and reliable for occult hernia identification. Compared to MDCT, MRI does not have ionizing radiation exposure or the potential consequences of iodinated intravenous contrast agents. As such, consider MRI when clinical suspicion is high despite negative prior studies when exam is non-congruent with reported symptoms, and for atypical presentations of groin pain. Limitations to MRI include cost and potentially limited accessibility, and variability in insurance coverage for hernia evaluation. In general, MRI is seldom used for the evaluation of direct inguinal hernias.

Imaging After Direct Inguinal Hernia Repair and Complications

Complications such as hernia recurrence, hematoma, seroma, mesh infection, and bowel obstruction can occur after direct inguinal hernia repair. A detailed discussion of surgical repairs for direct inguinal hernia is beyond the scope of this chapter, but non-surgeon clinicians and radiologists should have a basic understanding of repair approaches, techniques, prosthetic meshes, and expected postoperative changes when considering and interpreting imaging studies for suspected complications.

In general, inguinal hernia repairs are performed either from an anterior/open approach or a posterior/minimally invasive (laparoscopic or robotic) approach. After all minimally invasive repairs, some degree of subcutaneous and preperitoneal air is expected on cross-sectional imaging, as well as intraperitoneal air after laparoscopic transabdominal pre-peritoneal (TAPP) repairs. Although some pneumoperitoneum is not abnormal after TAPP, the intra-abdominal nature and incising of the peritoneum during this approach create unique but rare risks including iatrogenic bowel injury and intestinal obstruction. With respect to obstruction, failure to reapproximate the peritoneal flaps created during repair can allow bowel entrapment in the pre-peritoneal space and potentially bowel obstruction or strangulation through an internal hernia in the peritoneal closure. Thus, given the gravity of consequences if unrecognized, patients with evidence of early postoperative obstruction or developing peritonitis warrant strong consideration for reexploration even if imaging is not confirmatory.

Most modern-day open and minimally invasive repairs involve the placement of prosthetic mesh in the affected groin for both direct and indirect repairs. Large pore polypropylene mesh is typical for use, and this material is invisible or poorly visible on MDCT due to its isoattenuation compared to the surrounding abdominal wall muscle and fascia. Polytetrafluoroethylene mesh, conversely, has higher attenuation and is readily visible on MDCT. Mesh-related infections in the groin are uncommon after both open and minimally invasive approaches without typical risk factors.

Postoperative fluid collections can be evaluated by MDCT and US. Seromas commonly occur in the inguinal canal and adjacent to prosthetic mesh postoperatively and are generally self-limited, resolving within weeks following the operation. MDCT is typically sufficient to differentiate simple fluid from abscess or hematoma; however, US can also establish this diagnosis as well by demonstrating anechoic fluid. Hematomas are characteristically hyperattenuating on MDCT versus hypoechoic and heterogeneous and complex on sonogram. Additionally, as most seromas will resolve spontaneously, imaging can be deferred if the seroma is decreasing in size on serial office examinations. Figure 11.12 demonstrates the US appearance of a postoperative hematoma after a direct inguinal hernia repair.

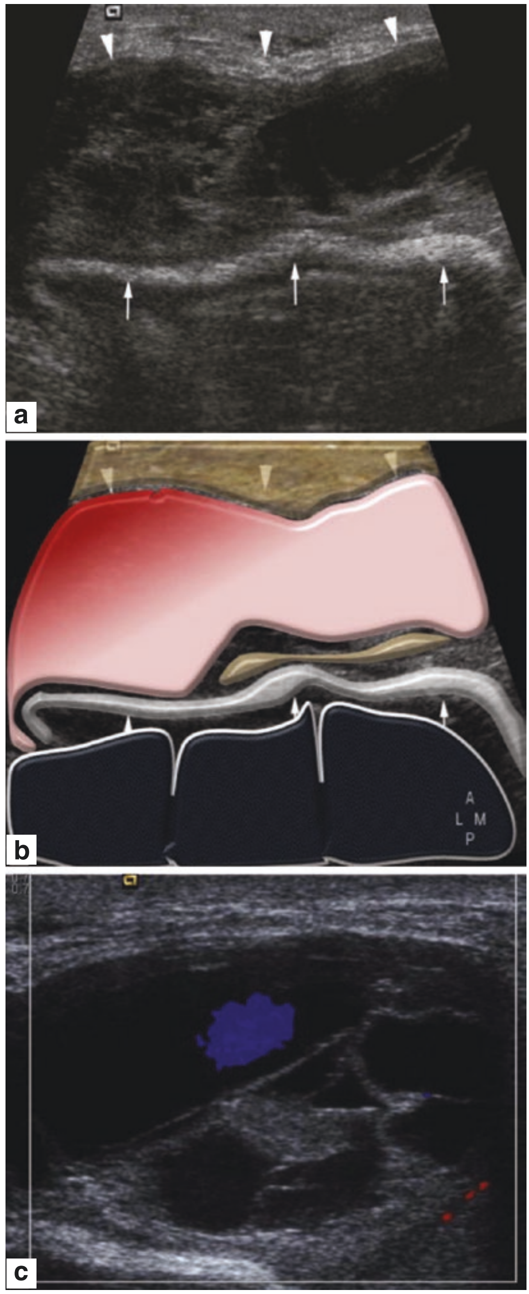

Fig. 11.12 Left inguinal mass after direct hernia repair, transverse sonograms. (**a**, **b**) A well-defined hyperechoic linear structure (arrows) lies on the deep aspect of the inguinal canal and has the typical appearance of a mesh placed over the posterior inguinal wall. However, filling the canal is a lobulated, predominantly heterogeneous soft tissue mass consistent with a postoperative hematoma (arrows). (**c**) Color Doppler shows no flow within the solid areas
With permission from: Practical Musculoskeletal Ultrasound [Philip Robinson]. Disorders of the Groin and Hip: Groin Pain

Conclusion

In summary, direct inguinal hernias occur in Hesselbach's triangle. Although a thorough history and physical exam obviate the need for radiologic evaluation of inguinal hernias in most situations, multiple imaging modalities exist to aid diagnosis when indicated. Dynamic US is the preferred modality to image direct inguinal hernias. MDCT and to some extent MRI are also useful in characterizing hernias and differentiating from non-hernia inguinal pathology. Finally, imaging can be useful when evaluating for complications after herniorrhaphy.

Further Readings

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