We are IntechOpen,
the world's leading publisher of Open Access books
Built by scientists, for scientists

6,900
Open access books available

185,000
International authors and editors

200M
Downloads

Our authors are among the

154
Countries delivered to

TOP 1%
most cited scientists

12.2%
Contributors from top 500 universities

CLARIVATE ANALYTICS
BOOK CITATION INDEX
INDEXED

WEB OF SCIENCE™

Selection of our books indexed in the Book Citation Index
in Web of Science™ Core Collection (BKCI)

Interested in publishing with us?
Contact book.department@intechopen.com

Imaging of Hernias

Mohamed Abdelmohsen Bedewi and
Mohamed El-sharkawy

Additional information is available at the end of the chapter

Abstract

Abdominal wall hernias are usually suggested by the patient's history and confirmed by physical examination; however, the history may be not typical, especially in patients with abdominal pain, distention, and overweight patients or in patients with small hernias located in unusual sites. Although most abdominal hernias are asymptomatic, the fear of developing complications like irreducibility, incarceration, and strangulation may necessitate prophylactic surgical repair; thus, early and accurate diagnosis is important. Before 20 years, herniorrhaphy was considered for imaging of hernias; however, in recent years, computed tomography (CT) (especially multidetector CT (MDCT)), together with ultrasound represented the mainstay of the diagnosis of abdominopelvic wall hernias by imaging, and magnetic resonance imaging (MRI) could be used as a diagnostic aid in a minority of the cases. Each imaging modality has its own privilege. The main advantage of ultrasound is the dynamic ability for assessment, while the main advantage of computed tomography is the multiplanar reformatting, allowing identification and accurate diagnosis of the hernia type, its content, and also the associated complications. Radiologists should be familiar with common sites of hernias and their detailed normal anatomy in order to reach the diagnosis easily.

Keywords: hernia, ultrasound, imaging, abdominal wall, strangulation

1. Introduction

Abdominal wall hernias are mostly diagnosed by typical history and clinical examination; however, in some cases, the history is not typical, especially in patients with marked abdominal distention, and overweight patients or in cases of occult hernias. Although most abdominal hernias are asymptomatic, the fear of developing complications like irreducibility, incarceration, and strangulation may necessitate prophylactic surgical repair; thus, early and accurate

diagnosis is important. Before 20 years, herniorrhaphy was considered for imaging of hernias; however, in recent years, computed tomography (CT) (especially multidetector CT (MDCT)), together with ultrasound represented the mainstay of the diagnosis of abdominopelvic wall hernias by imaging, and magnetic resonance imaging (MRI) could be used as a diagnostic aid in a minority of cases. Each imaging modality has its own privilege. The main advantage of ultrasound is the dynamic ability for assessment, while the main advantage of computed tomography is the multiplanar reformatting [1, 2, 3], allowing identification and accurate diagnosis of the hernia type, its content, and also the associated complications. MDCT technology also has the benefit of fast acquisition times, which reduces motion artifact, such as those related to bowel peristalsis and respiration. MDCT also has the postprocessing ability to manipulate the data to create three-dimensional surgical planning models [4]. Radiologists should be familiar with common sites of hernias and their detailed normal anatomy in order to reach the diagnosis easily [5] (**Figures 1**, **2**).

The absence of a reducible mass or a palpable defect does not rule out the presence of hernia. The term "hidden hernia" describes the situation when physical examination fails to demonstrate a palpable defect or a reducible mass, but the hernia sac is identified on surgical exploration [6]. The role for diagnostic imaging is to support clinical suspicion. Another important issue is to distinguish other lesions mimicking hernias, like desmoid tumors in the abdominal wall, seromas, abscesses, and hematomas. In inguinal region, abscesses, lipomas, and encysted hydrocele of the spermatic cord represent the most common lesions which could be put in the differential diagnosis of masses seen in the common sites of inguinal region hernias. In the next few pages, we will discuss our experience in imaging of the common hernias which we confront in practice.
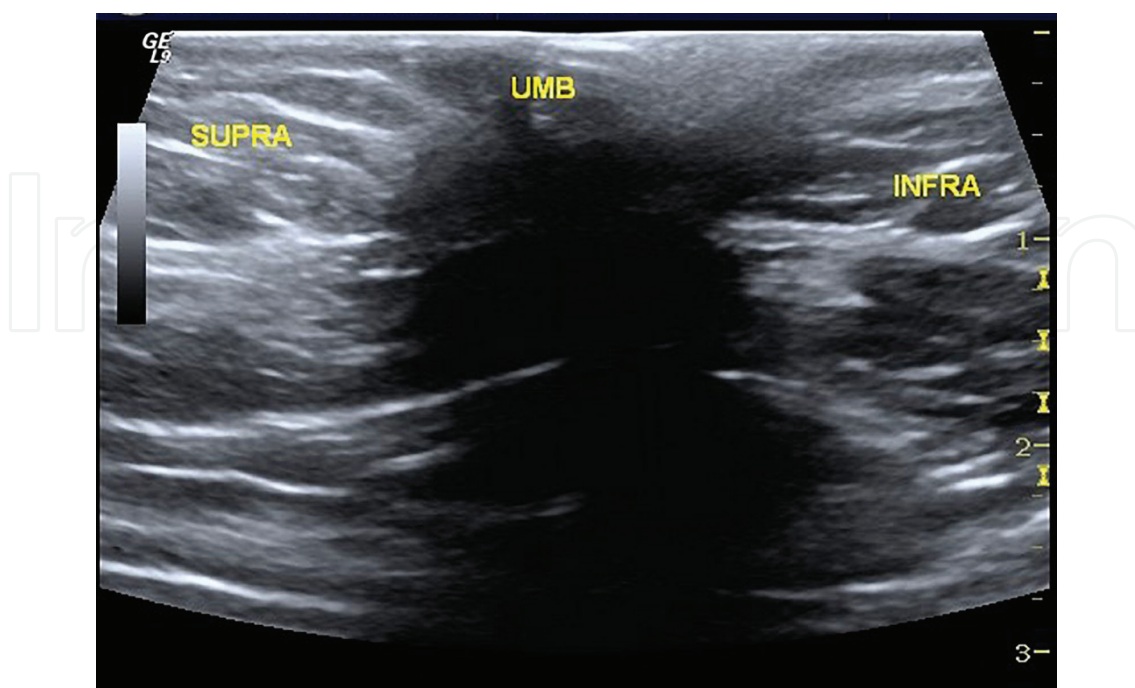

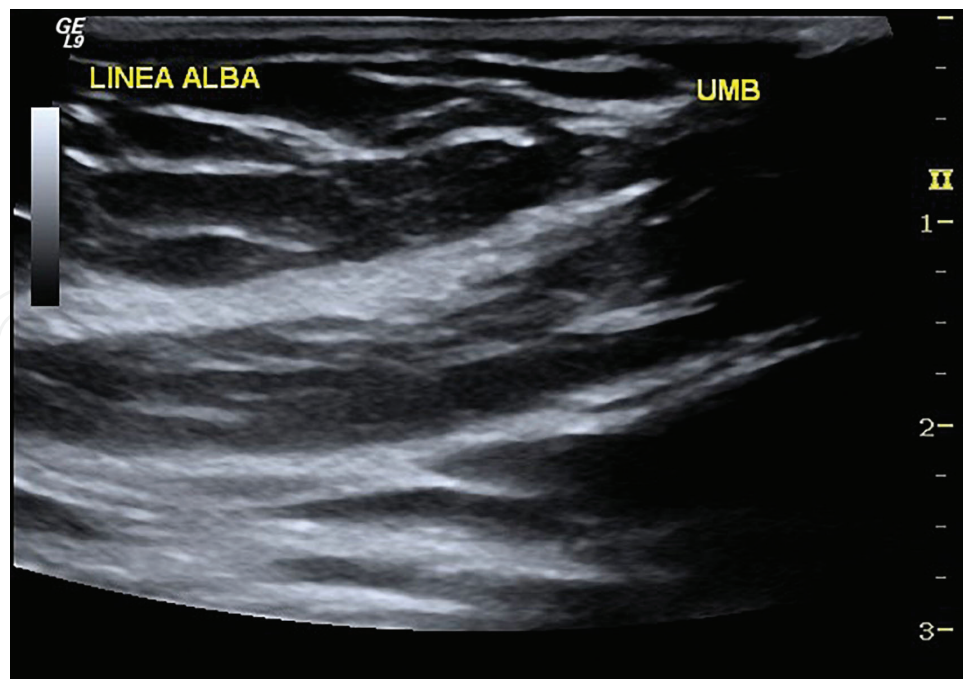**Figure 1.** Normal appearance of the umbilicus by ultrasound, short axis.

Figure 2. Normal appearance of the linea alba by ultrasound, long axis.

2. Inguinal hernia

Patients are usually diagnosed clinically, and most of the cases are operated without referral for imaging. There are two common types, direct and indirect; both are related to the inguinal ligament. By ultrasound, the inguinal ligament is seen as a dense echogenic line, and followed inferomedially, till the pubic region. The differentiation between direct and indirect inguinal hernias is by the relation of the hernia sac to the inferior epigastric artery where the more common indirect inguinal hernia lies lateral to it. The sac of the less common direct inguinal hernia lies medial to the inferior epigastric artery. The appearance of hernia sac is variable, and the defect of the hernia sac ranges from 0.2 to more than 3 cm and reaching 4 cm in some cases. The advantage of ultrasound over computed tomography lies mainly in the ability to perform a dynamic scan. A linear transducer (10–15 MHZ) is used to scan the inguinal region. If the sac is clear from the beginning of the scan, provocative tests could be excluded; otherwise, the simple use of Valsalva maneuver is recommended as a first-line dynamic maneuver, and the size of the defect is measured before and after the maneuver. The second provocative test is simple standing for 30 s, again the size of the defect is measured before and after standing (**Figure 3 (A)**, **(B)**), and the third test is to let the patient walk steadily for 2 min and then examine the patient in the standing position before lying supine (**Figure 4 (A)**, **(B)**, and **(C)**) (**Table 1**). The relatively echogenic edge of the sac is easily identified, and the content is usually fat, or omentum, less commonly bowel (**Figure 5**), or a mix of all these. The relation to spermatic cord has to be determined. Irreducibility has to be reported if present. It is always recommended to examine the asymptomatic side (**Figure 6**). The examination should extend to include the scrotal sac in male patients, to assess the extension of the sac, and to detect associated hydrocele. Color Doppler is occasionally used to see the vascularity and hence to
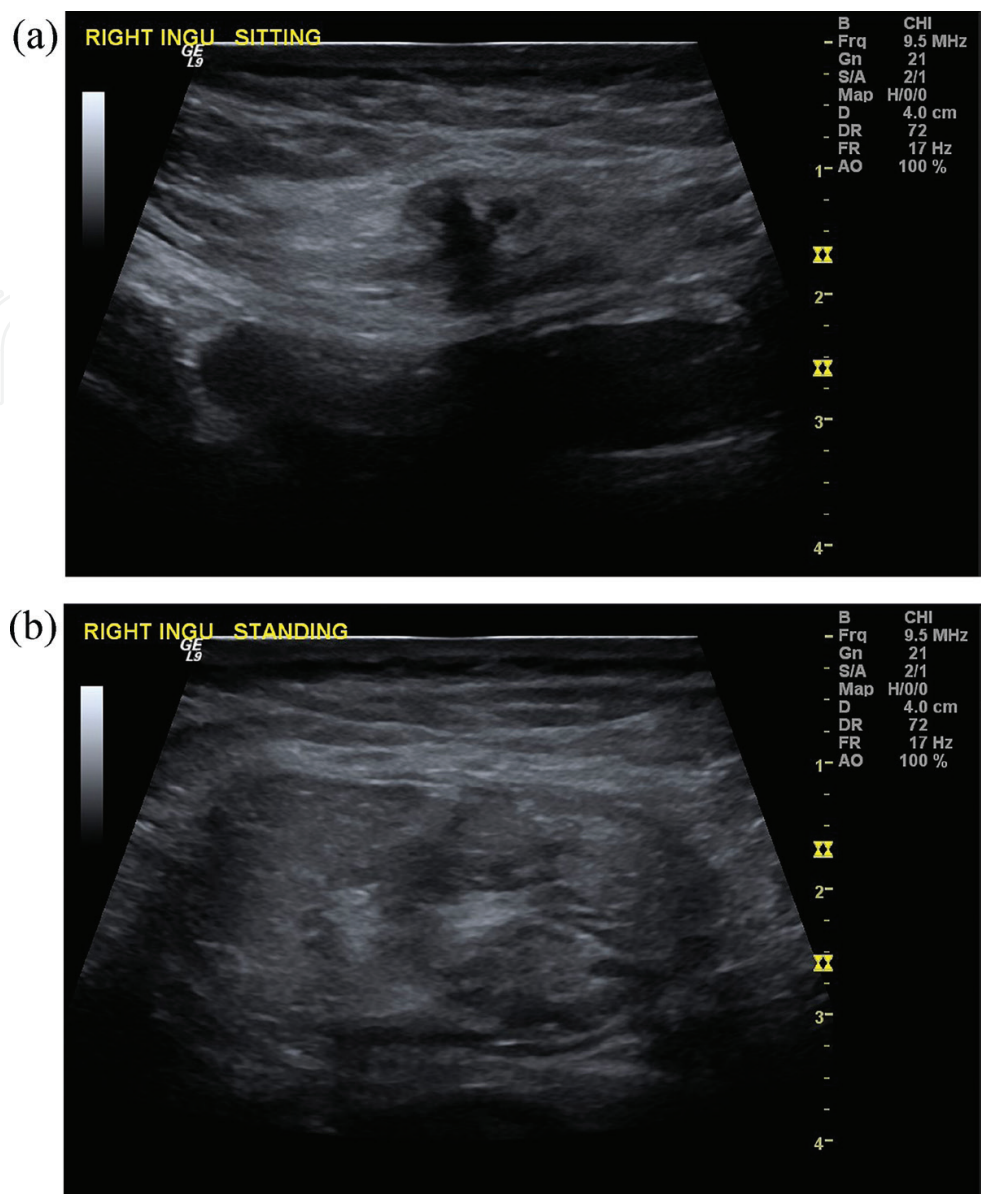
Figure 3. (A) Ultrasound right indirect inguinal hernia, sitting position. (B) Ultrasound right-sided indirect inguinal hernia standing.

indicate viability of the contents inside the sac. Care must be taken not to press too much with the transducer, because this may reduce small hernias (**Table 2**).

On computed tomography, the deep inguinal ring, is lateral to the inferior epigastric artery. The indirect inguinal hernia passes from lateral to medial, along the canal, and the neck is lateral and above the inferior epigastric vessels. The direct inguinal hernia enters the canal medial to the deep inferior epigastric artery, through Hesselbach's triangle, superior to inguinal ligament. The inferior epigastric and femoral vessels, are of key importance when diagnosing inguinal hernias as mentioned before in contrast to enhanced CT discriminating between direct and indirect hernias[4].
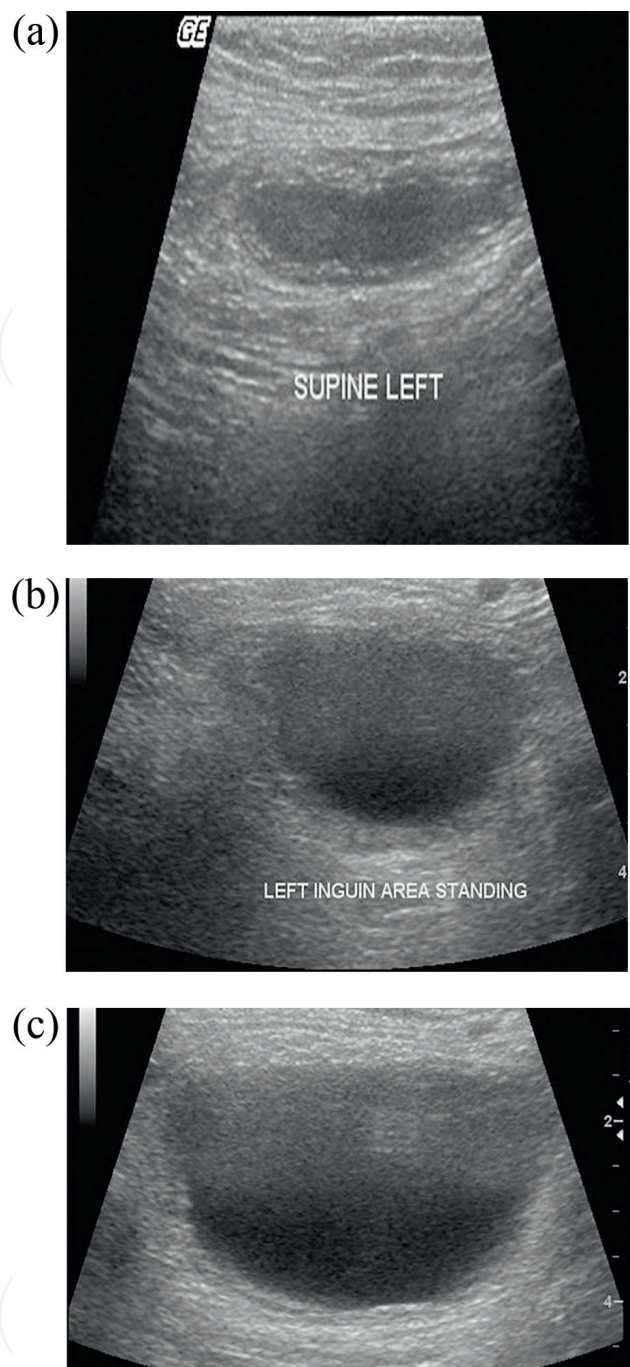
Figure 4. (A), (B), (C) inguinal hernia with provocative tests.

1- Valsalva maneuver

2- Standing and supine position

3- Provocative walking

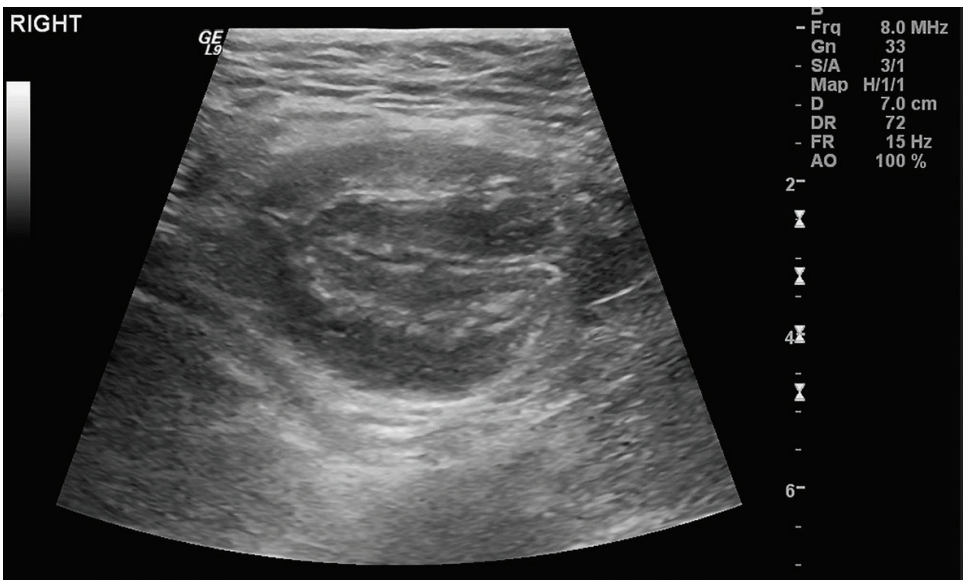**Table 1.** Dynamic maneuvers used for ultrasound of the inguinal hernia.

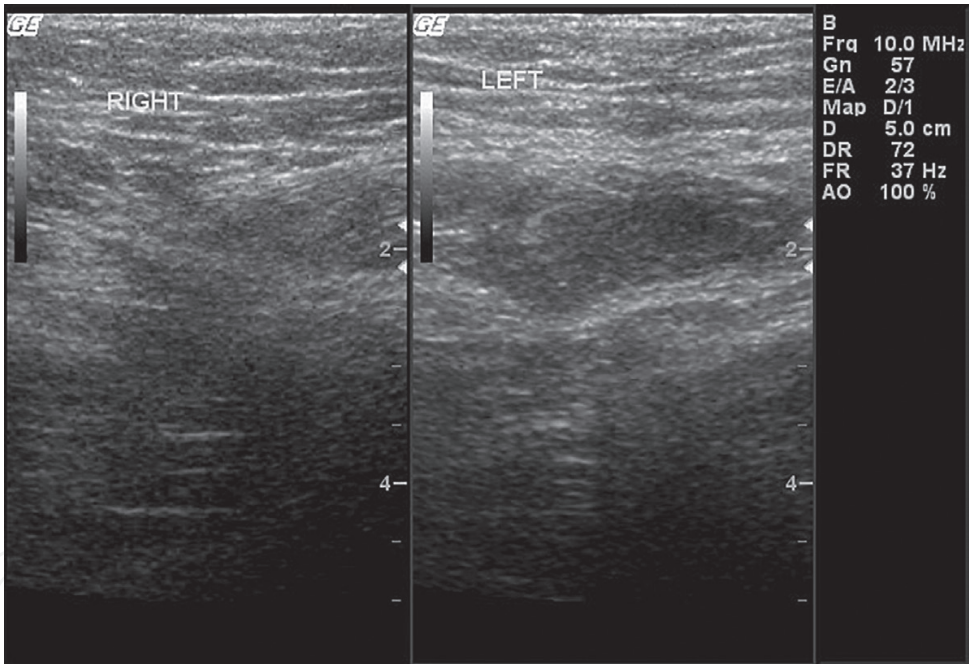**Figure 5.** Right inguinal hernia with bowel content.

Figure 6. Comparison of the normal right inguinal hernia, to the left side of the inguinal canal with indirect inguinal hernia.

Transducer: linear, 10–15 MHZ

- Check type, and relation to the inferior epigastric vessels (direct, indirect)

- Size of the defect

- Hernia sac content

- Compare both sides

Table 2. Checklist of ultrasound exam inguinal hernias.

3. Umbilical hernia

Acquired umbilical hernia is usually associated with multiparty and increased body mass index. Commonly, the patient is referred to ultrasound if the hernia is not obvious clinically, due to its dynamic and real-time capabilities, and ability to compare both sides of the abdominal wall. It is important for the radiologist to assess the hernia orifice and size of the defect (**Figure 7**). In small-sized hernias, contents of the hernia sac are usually only omental fat (which appears slightly hyperechoic); however, intestinal loops may be present in larger size umbilical hernias, and it could be easily identified by the appearance of dirty shadowing of gas and peristaltic movement (**Figure 8**). Color and power Doppler could be used to assess its viability. The use of Valsalva maneuver has been described for both ultrasound and computed tomography [7], and in our center, this is done in the supine position. Operator dependence and long learning curve are drawbacks for ultrasound scanning. Differentiation between true hernia and other masses like desmoid tumors, or collections whether inflammatory like abscesses or noninflammatory like seromas located in the paraumbilical region, is detected by both ultrasound and computed tomography.

Small hernias could be assessed by a linear transducer 10–15 MHZ, while larger size umbilical hernias with large-sized defect should be assessed by a curvilinear transducer 7–15 MHZ. The diagnostic yield of the ultrasound decreases with large-sized hernias; hence, it is recommended in this case to refer to multidetector computed tomography, where sagittal and axial reconstruction could add some information in addition to axial sections. The presence of the surgeon or the referring physician at the time of scanning is suggested to facilitate diagnosis.
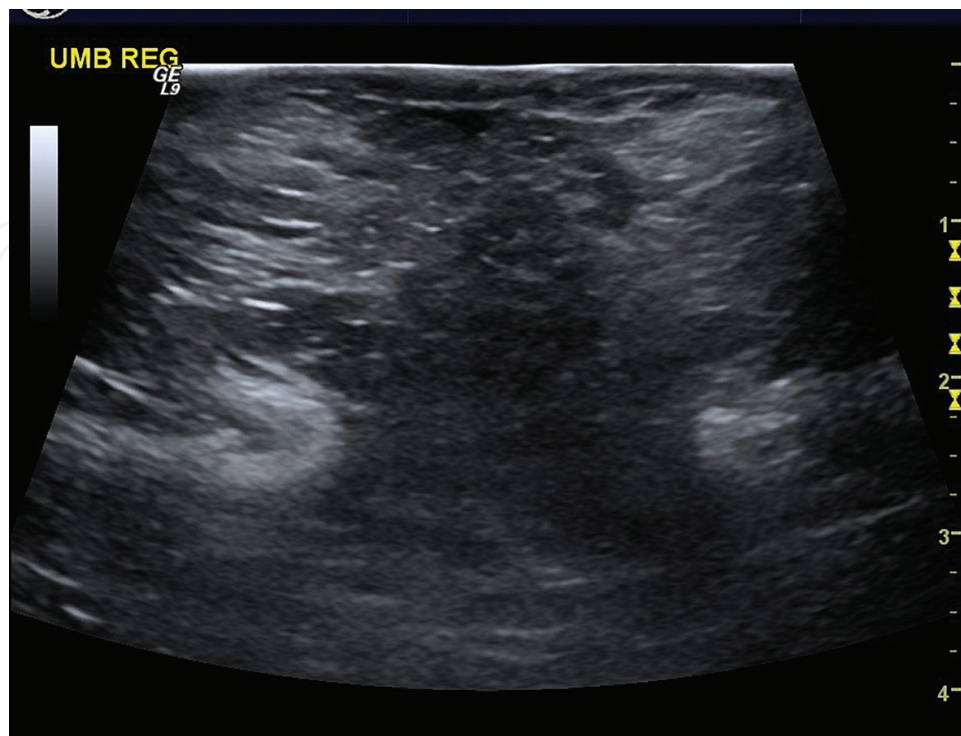

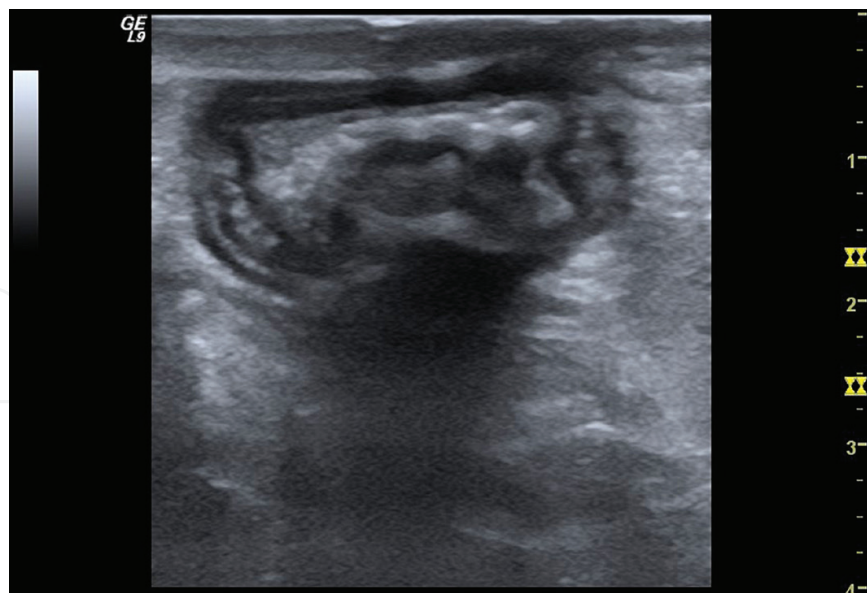**Figure 7.** Clear defect of hernia orifice, umbilical hernia.

Figure 8. Umbilical hernia with intestine.

4. Epigastric hernia

It occurs in the midline above the umbilicus till the xiphisternum. Diastasis of the rectus abdominis muscle often predisposes to epigastric hernias and fatty hernia of the linea alba. Defects are usually small sized, and the content is almost always fat [8]. They have to be differentiated from other causes of epigastric pain. They could be confused with paraumbilical hernia/swelling if they are near to the umbilicus. The defect is usually small (less than 1 cm) and appears as a hypoechoic interruption of the echogenic linea alba (**Figure 9**).

Figure 9. Midline epigastric hernia.

5. Spigelian hernia

It is named after the anatomist (Adriaan van der Spieghel) and is a rare lateral abdominal wall hernia. Most of these hernias have narrow neck and wide fundus, hence predisposing to irreducibility, incarceration, and strangulation [9] (**Figure 10**). Spigelian hernias are common in obese women, and clinical diagnosis is difficult. The hernia classically occurs caudal to the umbilicus but cranial to the junction of the linea semilunaris and the inferior epigastric vessels. Spigelian hernias traverse through the full thickness of the abdominal wall muscles [4]. Before three decades, herniorrhaphy (using contrast) was the mainstay for radiological diagnosis; however, in the last few years, the use of ultrasound has become much increased, with the capability of dynamic scanning and comparison to the asymptomatic side. A linear transducer (10–15 MHZ) is usually used for scanning; however, in obese patients, a curvilinear transducer (2–7 MHZ) is used. The use of color Doppler is helpful in the diagnosis of serious complications and incarceration and strangulation by checking the viability of the intestinal loops [8]. The second choice for diagnosis in modern imaging is computed tomography which displays excellent anatomy of the abdominal wall, especially with multidetector modern scanners; however, the risk of radiation makes it the second choice after ultrasound. An important point in either ultrasound or CT is the ability to identify the hernia orifice at the junction of the semilunar line and the semicircular line. It is important to establish a confident relationship between the radiologist and the surgeon in diagnosis of this type of hernia, as a number of cases of Spigelian hernia are falsely negative on radiologic investigation.
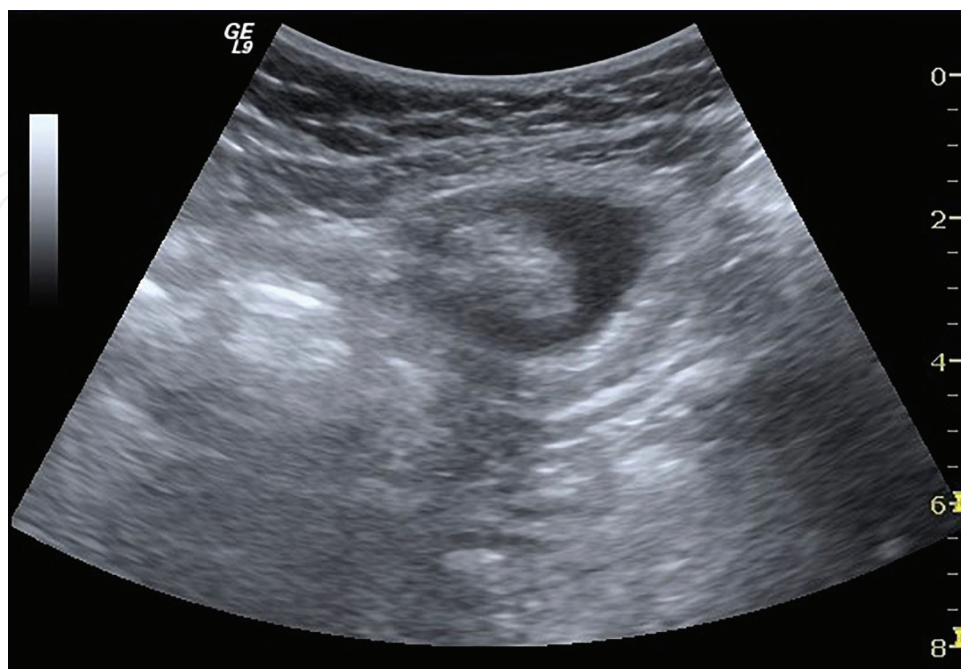

Figure 10. Ultrasound Spigelian hernia.

6. Femoral hernia

It is a rare hernia that is more common in females, likely attributed to increased intrapelvic pressure. A linear transducer of 10–15 MHZ is used, and scanning begins by identifying the echogenic inguinal ligament, then sweeping the probe inferomedially to identify the common femoral vein (**Figure 11**), where the usual site of hernia defect is medial to it. The importance of early diagnosis lies in the small size of the hernia sac of this type of hernia, making it prone to higher incidence of serious complications like strangulation. The differentiation of femoral hernia from direct and indirect inguinal hernias is not easy from the clinical point of view, and in this moment, the use of cross sectional imaging tool like CT is much more useful. On CT, the sac of an incarcerated femoral hernia lies lateral to the pubic tubercle, while the sac of the inguinal hernias is usually located medial to the pubic tubercle. Compression of the femoral vein within the canal is an important sign which could be demonstrated by both CT and ultrasound [10].
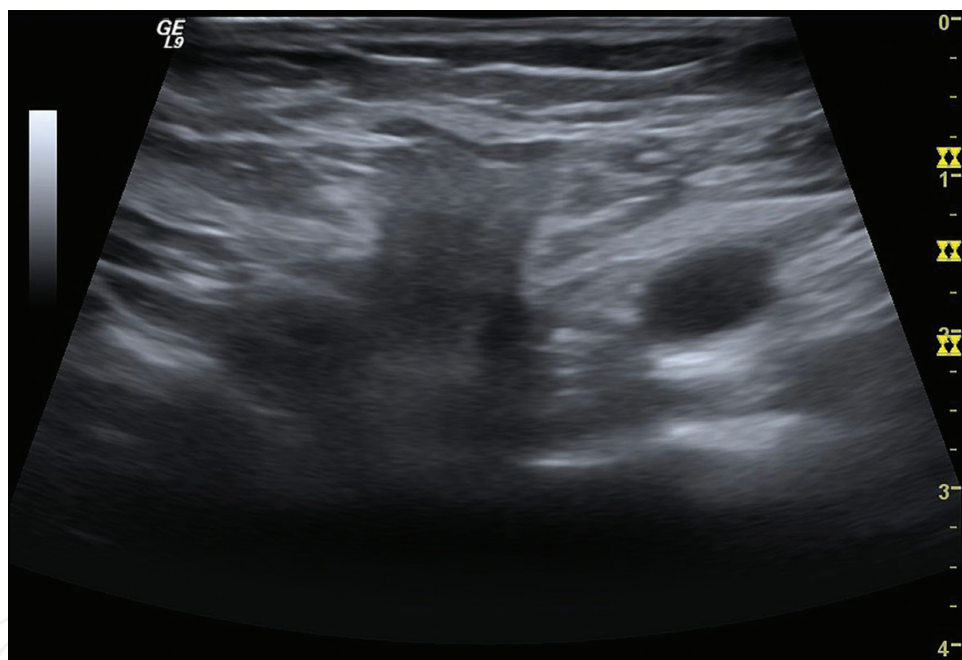

Figure 11. Left femoral hernia, note the sac is medial to left common femoral vein.

7. Obturator hernia

It is a rare type of hernia that is related to the obturator foramen and is associated with high risk of complications, hence, high morbidity. Referral for imaging is usually due to unexplained groin pain. On computed tomography, the hernia sac protrudes through the obturator foramen and lying between the obturator externus muscle from the posteromedial aspect and the pectineus muscle from the antero-lateral aspect [11].

8. Incisional and Para-stomal hernias

It is an important type of hernia that is related to the surgical incision or laparoscopy stomas. They are commonly associated with vertically oriented incisions and less frequently with transverse incisions. They could also occur with laparoscopy port sites. Para-stomal hernias are incisional hernias that occur around a stoma [4]. Incisional hernias are associated with high rate of postsurgical complications, with or without weakness of the abdominal wall muscles. The prognosis of the incisional hernia is highly related to how much of the thickness of the abdominal wall is involved by the hernia. Diagnosis could be done by ultrasound especially with the use of dynamic maneuvers; however, in cases of recurrent large incisional hernias, we recommend the use of CT as the edge of the hernia orifice may appear beyond the scope of the curvilinear abdominal low-frequency ultrasound probe. Also in cases of lateral incisional hernias (especially subcostal type), better localization of the hernia orifice is made by the modern multislice CT scanners, using the coronal and sagittal reconstruction.

9. Role of imaging in complications of hernias and postoperative period

Complications of hernias include irreducibility (**Figure 12**), obstruction, incarceration (**Figure 13 (A)** and **(B)**), and strangulation. Differentiating irreducibility from incarceration in terms of imaging is important. In our experience, simple failure of the hernia sac contents to reduce
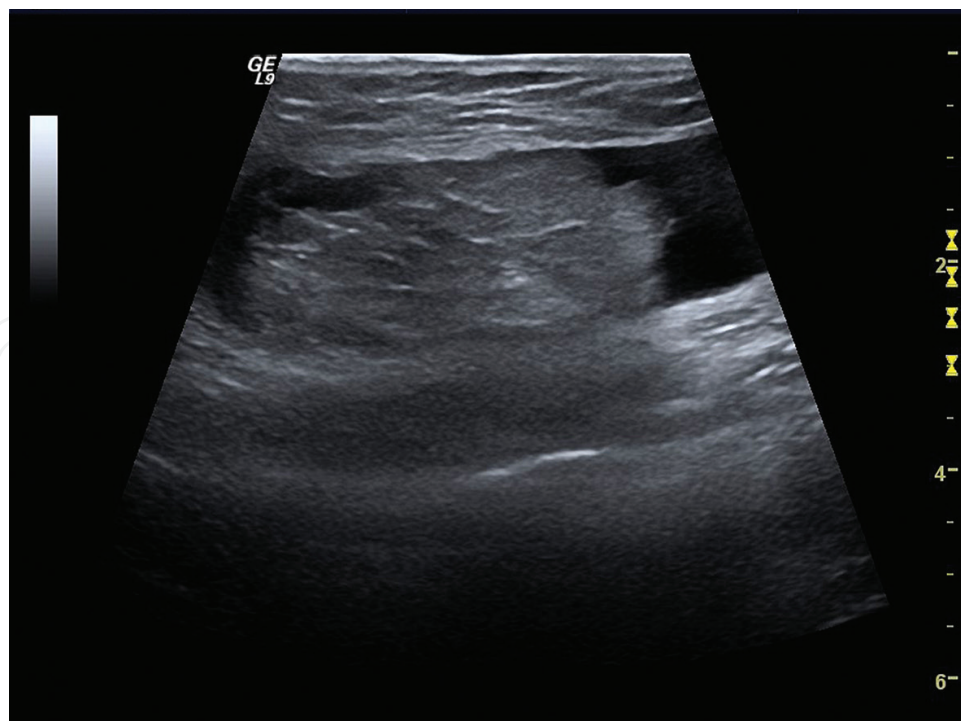

Figure 12. Irreducible umbilical hernia.

back into the sac after provocative tests should be defined as irreducibility, while presence of adhesion in addition to irreducibility signifies incarceration, and the addition of impedance of the vascular supply to the contents which are usually bowel loops signifies "strangulation." The use of color Doppler in diagnosing vascular compromise should be taken with caution, as the absence of positive vascularity may not be always associated with strangulation, and the presence of positive blood flow within the loops does not exclude strangulation. Vascular compromise is rather suggested by indirect signs of like thickening of the bowel wall, and presence of fluid inside the hernia sac.

Clinical evaluation of recurrent hernias is usually limited due to the existence of mesh (made of nonabsorbable material), and tissue fibrosis or large body habitus, contraction of the abdominal wall muscles, or any cause of distension. Under these circumstances, we usually resort to multi-detector row computed tomography for proper diagnosis. Complications after surgical hernia repair may comprise high percentage of cases, depending on surgical technique and the status of the hernia sac vasculature. Approximately one-half of these complications may require surgical re-intervention, and accurate diagnosis at multi-detector row CT is necessary for optimal patient treatment [2]. Assessment of the herniectomy site includes assessing the wound area for any collections, hematoma, seroma (**Figures 14** and **15**), stitch abscess, and recurrence. It is important to compare to the asymptomatic side and to assess the size of any collection present. Follow-up may be necessary for some complications such seroma, which have high rate of recurrence even after ultrasound-guided aspiration. The assessment of inserted mesh includes assessment of the edge and competence of the mesh, detecting any
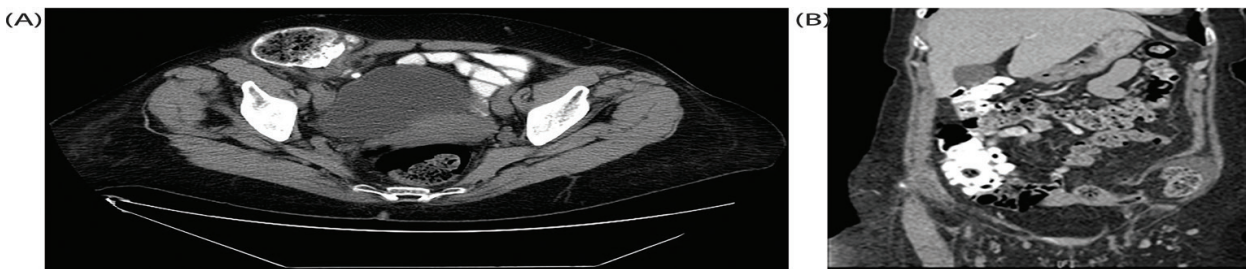

Figure 13. (A) CT incarcerated Spigelian hernia, axial. (B) CT incarcerated Spigelian hernia, coronal reconstruction.
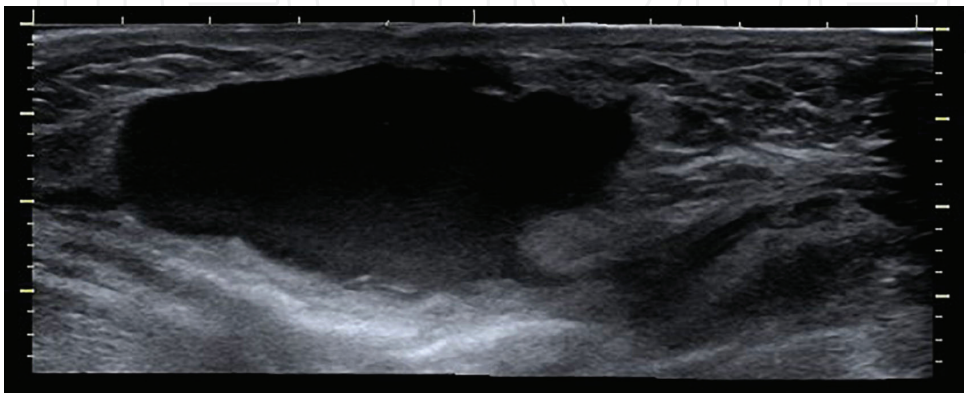

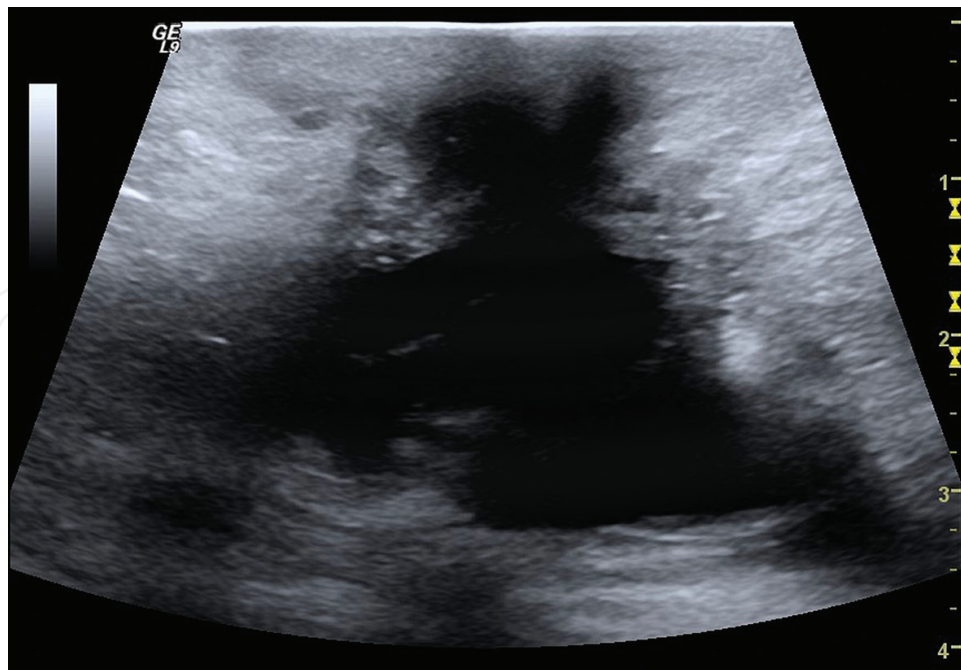**Figure 14.** Seroma postinguinal hernia repair.

Figure 15. Seroma postumbilical hernia repair.

surrounding collections, and to exclude mesh failure, this is usually associated with dense posterior shadowing.

10. Magnetic resonance imaging.

The use of magnetic resonance imaging was recently suggested for occult inguinal hernias [12]. It may be considered as the alternative imaging of choice, only if ultrasound and computed tomography failed to answer the question about the suspected hernia site. Magnetic resonance imaging is an important multiplanar imaging, however, its use is only resorted to, only after other cheaper and more available imaging modalities, like ultrasound and CT [9].

Author details

Mohamed Abdelmohsen Bedewi[1]* and Mohamed El-sharkawy[2]

*Address all correspondence to: mohamedbedewi@yahoo.com

1 College of Medicine, Prince Sattam Bin Abdulaziz University, Alkharj, Kingdom of Saudi Arabia

2 King Khalid University Hospital, King Saud University, Riyadh, Kingdom of Saudi Arabia

References

[1]   Bedewi MA, El-Sharkawy MS, Al Boukai AA, Al-Nakshabandi N. Prevalence of adult paraumbilical hernia. Assessment by high-resolution sonography: A hospital-based study. Hernia. 2012;**16**(1):59-62

[2]   Aguirre DA, Santosa AC, Casola G, Sirlin CB. Abdominal wall hernias: Imaging features, complications, and diagnostic pitfalls at multi-detector row CT. Radiographics. 2005;**25**:1501-1520

[3]   Harrison LA, Keesling CA, Martin NL, Lee KR, Wetzel LH. Abdominal wall hernias: Review of herniography and correlation with cross-sectional imaging. Radiographics. 1995;**15**:315-332

[4]   Trainer V, Leung C, Owen RE, Venkatanarasimha N. External anterior abdominal wall and pelvic hernias with emphasis on the key diagnostic features on MDCT V. Clinical Radiology 2013; **38**:388-396

[5]   Rettenbacher T, Hollerweger A, Macheiner P, Gritzmann N, Gotwald T, Frass R, Schneider B. Abdominal wall hernias: Cross-sectional imaging signs of incarceration determined with sonography. AJR American Journal of Roentgenology. 2001;**177**:1061-1066

[6]   Herrington JK. Occult inguinal hernia in the female. Annals of Surgery. 1975;**181**(4):481-483

[7]   Jaffe TA, O'Connell MJ, Harris JP, Paulson EK, DeLong DM. MDCT of abdominal wall hernias: Is there a role for Valsalva's maneuver? AJR American Journal of Roentgenology. 2005;**184**:847-851

[8]   Smereczyński A1, Kołaczyk K1, Lubiński J1, Bojko S1, Gałdyńska M1, Bernatowicz E1. Sonographic imaging of Spigelian hernias. Journal of Ultrasonography. 2012;**12**(50):269-275

[9]   Light D, Chattopadhyay D, Bawa S. Radiological and clinical examination in the diagnosis of Spigelian hernias. Annals of the Royal College of Surgens of England. 2013;**95**(2):98-100

[10] Suzuki S, Furui S, Okinaga K, et al. Differentiation of femoral versus inguinal hernia: CT findings. AJR Am J Roentgenol. 2007;**189**:W78-83

[11] Miller PA, Mezwa DG, Feczko PJ, et al. Imaging of abdominal hernias. Radiographics. 1995;15:333-347

[12] Light D, Ratnasingham K, Banerjee A, Cadwallader R, Uzzaman MM, Gopinath B. The role of ultrasound scan in the diagnosis of occult inguinal hernias. International Journal of Surgery. 2011;**9**(2):169-172