Abstract

Even if the diagnosis of abdominal wall hernias is clinical, and the most appropriate test is ultrasound, in a large number of cases hernias are difficult to evaluate, or their presence is not suspected because of the patient’s biotype, the absence of symptoms, the presence of complications, or the appearance of rare hernias. Additionally, abdominal wall weakness resulting from surgery leads to eversion of sometimes unusual organs such as the liver, bladder, or appendix. The use of multidetector computed tomography (MDCT) is of great advantage when it is difficult to establish a diagnosis by other methods. Hernia may also be an incidental finding that should be considered for potential future complications. In this paper, we describe the main MDCT findings in abdominal wall hernias, including umbilical, epigastric, hypogastric, inguinal, Spigelian, lumbar, obturator, intercostal, and incisional hernias, as well as their content.

Keywords: Abdominal wall; Hernia; Multidetector computed tomography

Introduction

Abdominal wall hernias are the protrusion of the abdominal contents through an area of anatomic weakness, while an eversion is a subcutaneous protrusion of the intraabdominal contents through a weakened area of the abdominal or lumbar wall resulting from a previous surgical procedure, a gap secondary to blunt trauma or to congenital malformation (referred to as incisional hernia in the English-speaking literature)\(^1\).

Predisposition to the development of hernias is often related to any cause of increased intraabdominal pressure\(^1\), with the most common causes being obesity, chronic cough and ascites. Conditions that favor localized or generalized weakening of the abdominal wall, such as aging, trauma, previous surgery and deficient collagen, should also be considered\(^2\).

Hernias of the abdominal wall are common findings on multidetector computed tomography (MDCT), ranging from small hernias with fat content to large sacs containing loops or organs\(^1\). MDCT provides an excellent anatomic detail of the abdominal wall, allowing accurate identification of wall hernias and their differentiation from other abdominal masses, such as tumors, hematomas or abscesses. In addition, this method allows detection of evolutions in patients who are difficult to evaluate (e.g., obese patients, postsurgical patients or patients with abdominal wall scarring)\(^3\).

Abdominal wall hernias that may be found from the cephalic to the caudal area include: epigastric, ventral, Spigelian, lumbar, inguinal, femoral and obturator hernias. Incisional hernias, in turn, may be located at any site, as they do not follow a cephalocaudal direction. Their accurate classification may be established by anatomic repairs\(^4\).

The aim of this paper is to describe MDCT findings of the various types of abdominal wall hernias (inguinal, femoral, obturator, Spigelian, lumbar, intercostal, ventral and incisional) and their content, evaluating the presence of incarceration and obstruction (table 1).

Review

Inguinal hernias

Inguinal hernias, whether direct or indirect, are the most common abdominal wall hernias. They occur both in children (most often the indirect type) and adults (both direct and indirect types), and up to 15% of athletes complain of pubalgia\(^5\).

The inguinal canal is a diagonal passage formed by the aponeuroses of the three abdominal wall muscles. The anterior wall is formed by the aponeuroses of the internal and exter-
nal oblique muscles, the posterior wall by the transversalis fascia and the conjoint tendon, the superior wall by the aponeuroses of the internal oblique and transverse muscles, and the inferior wall by Poupart’s inguinal ligament. The indirect inguinal hernia passes through the internal inguinal ring into the inguinal canal to emerge through the external inguinal ring, lateral and superior to the course of the inferior epigastric vessels. It may extend along the spermatic cord or the round ligament into the scrotum or the labia majora, respectively. The neck of the hernia sac may be seen at the deep inguinal ring (fig. 1). A finding that helps characterization of this type of hernia is “the hook sign”, which takes its name from the concave shape adopted by the proximal course of the inferior epigastric artery on the axial plane when compressed by an indirect hernia.

Direct hernias emerge above the inguinal ligament medially to the inferior epigastric vessels, and are generally acquired. Their incidence increases with age due to weakening of the

Table 1: Type of hernias and their locations.

<table>
<thead>
<tr>
<th>Type of hernia</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inguinal</td>
<td>Direct: medial to the epigastric vessels</td>
</tr>
<tr>
<td></td>
<td>Indirect: within the inguinal canal, lateral to the epigastric vessels</td>
</tr>
<tr>
<td>Femoral</td>
<td>Protruding through the femoral canal below the inguinal ligament, medially to the femoral vessels</td>
</tr>
<tr>
<td>Obturator</td>
<td>Protruding through the obturator foramen, between the obturator and pectineal muscles</td>
</tr>
<tr>
<td>Lumbar</td>
<td>Disruption of thoracolumbar fascia at insertion of aponeurosis of internal oblique and transverse abdominal muscles</td>
</tr>
<tr>
<td>Spigelian</td>
<td>At the junction of the semilunar line and the arcuate line</td>
</tr>
<tr>
<td>Ventral</td>
<td>Umbilical: secondary to weakness in the umbilical canal</td>
</tr>
<tr>
<td></td>
<td>Epigastric: at midline through linea alba above umbilicus</td>
</tr>
<tr>
<td></td>
<td>Hypogastric: at midline through linea alba below umbilicus</td>
</tr>
<tr>
<td>Abdominal intercostal</td>
<td>It occurs through a lower intercostal space by various mechanisms</td>
</tr>
<tr>
<td>Incisional (eventration)</td>
<td>It may occur at any site of the abdomen where there is an incision or wall weakness</td>
</tr>
</tbody>
</table>

Figure 1 Axial multidetector computed tomography image shows an indirect inguinal hernia (curved arrow) with fat and small bowel loops contents. Note the epigastric vessels (black arrow) and the hernia neck (straight white arrows).

Figure 2 Axial multidetector computed tomography image shows a direct inguinal hernia (curved arrow), medial to femoral vessels (straight arrow), containing bowel loops. Note the epigastric vessels (black arrow).
transversalis fascia in the Hesselbach triangle. They are more common in men and are less often associated with strangulation of the loops, possibly because they usually do not traverse the entire course of the canal (fig. 2). The inguinal canal contents are compressed laterally, while the fat of the canal is shaped as a moon crescent, resulting in the crescent sign (a finding that is helpful for characterization of direct inguinal hernias).

**Femoral hernia**

Less common than inguinal hernias, femoral hernias occur when the peritoneal content protrudes into the femoral canal with the femoral vein and artery. This region is simpler than the inguinal canal in its configuration, bordered superiorly by the inguinal ligament, medially by the medial border of the adductor muscle, laterally by the Sartorius muscle with the ilio-psoas, pectineal and long adductor muscles forming its floor. The main characteristic of the triangle is the femoral sheath, which is formed by the deep fascia (fascia lata) of the thigh and contains the femoral artery, the femoral vein, and the femoral canal, from lateral to medial. This type of hernia is more common in women and it usually occurs on the right side.

On MDCT the neck of the hernia sac can be seen as a narrow protrusion through the femoral ring, caudal to the origin of the inferior epigastric vessels and medial to the common femoral vein, which often appears compressed by the hernia sac (fig. 3). Sometimes at clinical examination it is difficult to differentiate between femoral and inguinal hernias; therefore MDCT plays an important role in differentiation and assessment of hernia contents. The hernia sac most frequently contains small bowel loops; however, the appendix may also be found within this canal, which is rare (1% of cases) and known as De Garengeot hernia (table 2).

**Obturator hernia**

The clinical diagnosis of obturator hernia is difficult because its incidence is uncommon, its location is deep and there are few

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**Figure 3** Coronal (a) and axial (b) multidetector computed tomography images show a femoral hernia (curved arrow in b) with fat content and a loop of small bowel (straight arrow in a), causing closed loop intestinal obstruction. Note the change in loop diameter (curved arrow in a).

**Table 2:** Location of inguinal and femoral hernias.

<table>
<thead>
<tr>
<th>Indirect inguinal hernia</th>
<th>Direct inguinal hernia</th>
<th>Femoral hernia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hernia neck anterior to the inguinal ligament, lateral to the inferior epigastric vessels</td>
<td>Hernia neck anterior to the inguinal ligament, medial to the inferior epigastric vessels</td>
<td>Posterior to the inguinal ligament, medial to the femoral vessels</td>
</tr>
<tr>
<td>Search for the hook sign</td>
<td>Crescent Sign</td>
<td></td>
</tr>
</tbody>
</table>

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specific signs and symptoms, as those associated with obturator nerve compression (Howship-Romberg sign)\textsuperscript{10}. The obturator foramen is formed by the continuity of the pubic and ischial bones, and it is covered by the obturator membrane, except in the anterosuperior aspect, where it is perforated by the obturator artery, vein and nerve, which travel along a 2-3-cm tunnel formed by the internal and external obturator muscles. Peritoneal hernia develops through this defect\textsuperscript{11}.

Obturator hernias occur more commonly in elderly multiparous women, secondary to weakness of the pelvic floor, but they may also be seen in patients with increased abdominal pressure and in frail elderly patients\textsuperscript{1}.

Specific diagnosis can be made if the pelvic MDCT shows herniation of the small bowel between the external obturator and pectineal muscles, with small bowel obstruction with no apparent cause\textsuperscript{3} (fig. 4).

**Spigelian hernia**

A Spigelian hernia is a rare acquired ventral hernia\textsuperscript{4}. It occurs through defects in the aponeuroses of the internal oblique and transverse abdominal muscles, with a typical location at the junction of the semilunar line with the semicircular or arcuate line\textsuperscript{3}. It occurs laterally to the rectus abdominis muscle and inferiorly to the umbilicus and it is nearly always found above the level at which the inferior epigastric vessels perforate the posterior wall of the rectus abdominis sheath\textsuperscript{1}.

![Figure 4](image_url) Axial (a) and coronal (b) multidetector computed tomography images of a left obturator hernia (curved arrows). Straight arrows reveal the obturator foramen.

![Figure 5](image_url) Axial multidetector computed tomography image of right (a) Spigelian hernia with fat content (curved arrow), lateral to the anterior rectus abdominis muscle (straight arrow), and left (b) Spigelian hernia (curved arrow) with fat and small bowel loops contents (straight arrow).
Clinical diagnosis of Spigelian hernias is not easy because such hernias extend between muscular or fascial layers of the anterior abdominal wall. The hernia orifice may be small and difficult to locate, and often contains omental fat (fig. 5a), small bowel loops (fig. 5b) or metastatic implants (fig. 6).

**Lumbar hernia**
Lumbar hernias may occur at weak points in the posterolateral abdominal wall: the superior lumbar triangle or triangle of Grynfelt, bordered superiorly by the twelfth rib, medially by the quadratus lumborum muscle, laterally by the internal oblique muscle and posteriorly by the spinal muscle; and the inferior lumbar triangle or Petit triangle bordered by the external oblique muscle anteriorly, the latissimus dorsi muscle posteriorly, and the iliac crest inferiorly.

Lumbar hernias are most often acquired (occurring spontaneously, secondary to trauma or postsurgically). Spontaneous hernias account for approximately 50% of all lumbar hernias and most frequently occur in the superior triangle; they may contain bowel loops, retroperitoneal fat or the kidney. Symptoms may be varied and confusing. Sometimes patients present with lumbar pain or post-incisional neuralgia (fig. 7).

**Intercostal Hernia**
Called abdominal intercostal hernia by some authors, this is a rare condition of which very little is known. It causes protrusion of fat or abdominal viscera under an intact diaphragm. The most common etiologies are thought to be trauma or surgery.

Intercostal hernias are mostly located under the ninth rib and the main symptoms are lower chest swelling and pain. Complications are similar to those of other hernias, namely, incarceration and strangulation (fig. 8).

Diagnosis is made by MDCT, which detects the hernia sac protruding between the ribs.

**Ventral hernia**
Ventral hernias include all hernias in the anterior and lateral abdominal wall, such as umbilical, epigastric and hypogastric hernias. Umbilical hernias consist of protrusion of the abdominal content through the umbilical ring. They are the most common type and have a variable size, ranging from very small (most usually) to middle-sized (fig. 9). They are ten times more common in women and their risk factors include multiple pregnancies, ascites and obesity (fig. 10). Epigastric hernias, in turn, develop on the linea alba, between the xiphoid process (fig. 11) and the umbilicus, while hypo-gastric hernias occur on the midline below the umbilicus.

**Incisional hernias (Eventration)**
An eventration is a subcutaneous protrusion of the intra-abdominal contents through a weakened area of the abdominal or lumbar wall resulting from a previous surgical procedure, a gap secondary to blunt trauma or to congenital malfor-
It may occur in any surgical incision on the abdominal wall, including the laparoscopic trocar insertion sites. It is more commonly encountered in association with vertical than with transverse incisions. Most incisional hernias develop during the first 4 months after surgery, a critical period for the healing of muscular layers of the abdominal wall. They may manifest signs and symptoms within the first year, although 5-10% may remain silent for a long period until their detection. Radiological studies may be used to visualize the herniated segments and to evaluate associated complications such as intestinal obstruction. They are often used in those patients who are difficult to evaluate, such as those with marked obesity, easily reducible hernia content or large scars (figs. 12 and 13).
Figure 12 Axial multidetector computed tomography image shows a middle-sized incisional hernia (curved arrow) containing small bowel loops (straight arrow).

Figure 13 Axial multidetector computed tomography identifies a transverse incisional hernia (curved arrow) showing eventration of the bladder roof (straight arrow).

Figure 14 Axial multidetector computed tomography image shows a large epigastric hernia (curved arrow) with protrusion of the left lobe of liver (black straight arrow), pyloric antrum and bowel loops (white straight arrow).

Figure 15 Axial (a) and coronal (b) multidetector computed tomography images show markedly distended gallbladder herniation (curved arrows).
**Figure 16** Axial multidetector computed tomography image of an umbilical hernia (curved arrow) with a solid implant (straight arrow) secondary to an ovarian tumor (Sister Mary Joseph’s node).

**Figure 17** Axial multidetector computed tomography of the abdomen shows an umbilical hernia (curved arrow) with peritoneal fat content (white straight arrow) and ascites (black straight arrow).

**Figure 18** Axial multidetector computed tomography image shows lumbar hernia (curved arrow) containing part of the right lobe of liver (straight arrow).

**Figure 19** Axial multidetector computed tomography image shows a large bilateral inguinal hernia (curved arrows) with distended small bowel loops (straight arrow).

**Figure 20** Axial (a) and sagittal (b) multidetector computed tomography detects an inguinal hernia (curved arrow) with protruding bladder roof (cystocele) (straight arrow).
Figure 21 Axial multidetector computed tomography identifies a small right inguinal hernia (curved arrow) containing the vermiform appendix (straight arrow), confirmed by surgery (Amyand hernia).

Figure 22 Axial (a) and coronal (b) multidetector computed tomography images show vermiform appendix (curved arrow) within the femoral canal, medial to the femoral vessels (straight arrow). This hernia is known as De Garengeot hernia.

Figure 23 Axial multidetector computed tomography shows a transverse incisional hernia (curved arrow) containing a transplanted kidney (black straight arrow) and the bladder roof (white straight arrow).

Figure 24 Sagital multidetector computed tomography of an incisional hernia (curved arrow) with protruding bladder (straight arrow).
Content

Content is associated with the different sites of abdominal wall weakness. Epigastric hernias may involve herniation of the pyloric antrum, left lobe of the liver (fig. 14) or gallbladder (fig. 15). Umbilical hernias may contain peritoneal fat, bowel loops, metastatic implants (Sister Mary Joseph’s node) (fig. 16) or ascitic fluid (fig. 17). Spigelian hernias usually contain fat and bowel loops, while obturator hernias are often detected because the patient presents with symptoms of mechanical bowel obstruction that help in diagnosis. Lumbar hernias may involve herniation of fat, the pole of kidney or the right lobe of the liver (fig. 18). Inguinal hernias have highly varied contents, although peritoneal fat and loops are the most common (fig. 19). They may also involve herniation of intrapelvic organs, such as the bladder (cystocele) (fig. 20) or the appendix (Amyand hernia) (fig. 21) and, if herniation of the appendix occurs within the crural canal, it is called De Garengeto hernia (fig. 22). Finally, incisional hernias contain large and small bowel loops, transplanted kidneys (fig. 23) and bladders (fig. 24).

Conclusion

Knowledge of the abdominal wall anatomy and the relationship of hernias with vascular structures, fascial and muscular layers is extremely important for determining the type of hernia. MDCT has demonstrated to be very useful for such purpose and can even identify the contents of hernias.

Confidentiality of data

The authors declare that they have followed the protocols of their work center on the publication of patient data and that all the patients included in the study have received sufficient information and have provided their written informed consent.

Conflicts of interest

The authors declare no conflicts of interest, except for Dr. Kozima, who declares a possible conflict of interest as member of the Executive Committee of SAR.

References