Anatomy of the Hole:
A CASE SERIES OF COMMON AND UNCOMMON STRUCTURES HERNIATING INTO THE INGUINAL CANAL

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Goals and Objectives

- Review the relevant anatomy of the inguinal canal
- Discuss the epidemiology and pathophysiology of inguinal hernias
- Discuss the role of imaging in management and potential complications requiring intervention
- Review the imaging appearance on multiple modalities of several interesting cases of inguinal hernias involving visceral organs as well as malignant and infectious processes
Inguinal hernia is a protrusion of peritoneal sac through the abdominal wall in the region of the inguinal canal. A common cause of groin or pelvic pain.

Lifetime risk of a spontaneous abdominal hernias is approximately 5%.

Inguinal hernias account for 75% of abdominal wall hernias.

There is a 7:1 male to female predilection.

The most common contents of inguinal hernias include fat and loops of bowel, but various other pelvic contents including ovaries, fallopian tube, uterus, bladder, and ureters have been described.

Approximately 5% of patients with inguinal hernia will require surgery.
The inguinal canal is a passageway through the anterior abdomen that connects the deep and superficial inguinal rings.

- The **superficial inguinal ring** is a defect in the external oblique aponeurosis.
- The **deep inguinal ring** lies halfway along the inguinal ligament posteriorly.

The boundaries of the inguinal canal include:

- The external and internal oblique muscle fibers anteriorly and transversalis fascia posteriorly.
- The internal oblique as well as the transverse abdominis muscles additionally form the roof of the inguinal canal laterally and the posterior wall of the inguinal canal medially as they attach to the pubic tubercle.
- The inguinal ligament forms the floor of the inguinal canal.

Anatomy of the Inguinal Canal
DIRECT INGUINAL HERNIA
• Contents protrude medial to inferior epigastric vessels, directly through HESSELBACH TRIANGLE
  ➢ Usually ACQUIRED → due to weakness in the transversalis fascia
  ➢ Incidence increases with age

INDIRECT INGUINAL HERNIA
• Contents protrude lateral to inferior epigastric vessels, through the deep inguinal ring
  ➢ Usually CONGENITAL → due to failure of embryonic closure of processes vaginalis
  ➢ May occur anytime, most present by 5th decade of life
**DIRECT INGUINAL HERNIA**

- Contents protrude medial to inferior epigastric vessels
- *Lateral crescent sign (white dotted line)* formed by the compression of inguinal canal contents is a useful diagnostic sign

**INDIRECT INGUINAL HERNIA**

- Contents protrude lateral to inferior epigastric vessels
“Pantaloone” or Dual Hernia

Key Findings

79-year-old male with abdominal pain. Sagittal (A), coronal (B), and axial (C and D) contrast-enhanced CT images of the abdomen and pelvis demonstrate bilateral inguinal hernias. On the right, there are two hernia sacs noted both medial and lateral to the inferior epigastric artery (thick blue arrows) representing concurrent direct (thin yellow arrows) and indirect hernia (thin blue arrows) sacs. Findings are compatible with a pantaloone hernia or dual hernia (or Romberg’s hernia).
Inguinal hernias can traditionally be diagnosed with physical exam
- However, radiological diagnosis is often necessary for:
  1. Diagnosis of occult hernias
  2. Identification of hernia contents as well as the choice of treatment
  3. Prognostication of patients with complicated inguinal hernias

Ultrasound is frequently the initial diagnostic modality of choice to evaluate inguinal hernias when there is no suspicion for hernia complications
- US is also frequently used to evaluate clinically occult hernias but has reported poor reliability

CT scan of the groin allows better localization of the hernia as well as identification of potential complications
- MRI has the highest sensitivity and specificity for diagnosis of occult inguinal hernia and may prove helpful when there is high clinical suspicion
- CT is also helpful in differentiating femoral from inguinal hernias when physical exam is not diagnostic
  - A hernia sac medial and superior to pubic tubercle is diagnostic of inguinal hernia
  - A hernia sac inferior and lateral to pubic tubercle is compatible with femoral hernia and often associated with venous compression
Hernia Complications

**INCARCERATION**
- Hernia contents are trapped within the hernia sac
- Hernia is not reducible on physical exam
- May present with or without other complications including strangulation/obstruction

Direct inguinal hernias have a much lower association with incarceration and strangulation compared to indirect

<table>
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<th>Key Findings</th>
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<td>47-year-old male with abdominal pain and painful urination due to non-reducible hernia. Oblique axial (A) and sagittal (B) contrast-enhanced CT of the abdomen and pelvis demonstrates a large right inguinal hernia containing fat and extensive stranding suggestive of an acute inflammation (yellow circle). This is inseparable from the anterior right bladder wall, which also demonstrates eccentric wall thickening. Findings are compatible with an <strong>incarcerated right inguinal hernia</strong>, which may have at some point included portions of the urinary bladder, explaining the associated eccentric bladder wall thickening.</td>
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Hernia Complications

• **BOWEL OBSTRUCTION**
  - Irreducible hernia containing bowel contents resulting in intestinal obstruction

• **STRANGULATION**
  - Irreducible hernia containing vascular contents resulting in compromise of blood supply
  - Imaging features can vary depending on time course
    - Abnormal visceral enhancement or vessel occlusion
    - Pneumoperitoneum/pneumatosis
    - Variable amounts of free fluid

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Key Findings

58-year-old female with abdominal pain, nausea, and vomiting. Sagittal (A) and coronal (B) contrast-enhanced CT of the abdomen and pelvis demonstrate multiple fluid-filled, dilated loops of small bowel with air-fluid levels, compatible with small bowel obstruction. There is a transition point at the neck of the hernia with a loop of fluid-filled small bowel within the hernia sac (yellow circle). There is mild fluid and fat stranding within the hernia sac, and differential mural enhancement of the bowel proximal and distal to the hernia defect, potential signs of a more urgent surgical case.
**Inguinal Hernia Mimic**

**Key Findings**

21-year-old female evaluation of adnexal cyst. MRI of the pelvis with and without contrast (A, B, C, and D) demonstrates a nonenhancing, thinly septated fluid intensity cystic structure (blue arrows) extending through the right inferior pelvic wall measuring 3.2 x 2.8 cm. Finding is compatible with a canal of Nuck cyst (or hydrocele).

- The **canal of Nuck** is a small evagination of parietal perineum that accompanies the round ligament through the inguinal ring to the labia majora
  - Homologous to the processus vaginalis in males
  - Failure of obliteration in the first year of life can result in development of indirect inguinal hernias or hydrocele
CASES OF COMMON AND UNCOMMON HERNIA CONTENTS
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**Key Findings**

82-year-old male with history of duodenal neuroendocrine tumor. Coronal (A) and sagittal contrast-enhanced CT of the abdomen and pelvis demonstrate fat and a loop of normal caliber, contrast filled herniated small bowel herniating into the right inguinal canal. Proximal and distal bowel loops seen on coronal image (A) with contrast-air levels seen and sagittal image (B). There is no radiographic evidence of strangulation or obstruction.
A 70-year-old man with history of bilateral inguinal hernias with massive bilateral scrotal enlargement. Initial CT of the abdomen and pelvis (A and B) demonstrates very large bilateral inguinal hernias with the left hernia fat and a large volume of fluid and the right hernia containing a normal appendix (blue arrows), multiple nondilated loops of small bowel, mesentery, fat, and fluid. Approximately one year later, CT of the abdomen and pelvis (C, D, E, and F) demonstrates further enlargement of the bilateral inguinal hernias now with herniated large bowel loops (yellow arrows) on the right including the cecum and portions of the ascending colon. Axial images (E and F) show bowel signature of contrast-filled small and stool-filled large bowel loops within the hernia sac.
Visceral Organs | Malignancy | Infection
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**Herniated Stone-filled bladder**

**Key Findings**

72-year-old male with right inguinal scrotal swelling, voiding dysfunction, and pain for several months. Multiple grayscale ultrasound images (A, B, and C) demonstrate a portion of bladder extending from the pelvis (A), through the inguinal canal (B), and terminating within the scrotum (C). Findings are compatible with a **herniated stone-filled bladder**. The bladder wall in the inguinal canal and scrotum is trabeculated and there are multiple shadowing stones (blue arrow) noted along the dependant portion of the herniated bladder.
Visceral Organs | Malignancy | Infection
---|---|---
**Herniated Stone-filled bladder**

**Key Findings**
Coronal (A) and sagittal (B) contrast-enhanced CT images of the same patient demonstrate a large right inguinal hernia containing a large portion of the bladder adjacent to a large right hydrocele. The bladder wall within the hernia sac is thickened and there are multiple stones within the herniated portion of the urinary bladder (blue arrows). The hernia sac is located medial to the inferior epigastric vessels representing a direct inguinal hernia.
65-year-old man with history of large right inguinal hernia interfering with quality of life. Multiphase contrast-enhanced CT of the abdomen and pelvis (A, B, C, and D) demonstrates a large right inguinal hernia (dotted blue line) containing fat and a dilated herniated right ureter, which fills with contrast from nephrographic to excretory phase images (A and B). The right ureter extends from the dilated renal pelvis, into the hernia sac, then exits the hernia sac and inserts into the urinary bladder. The course of the herniated ureter within the hernia sac is best seen on sagittal image (D).
**Visceral Organs | Malignancy | Infection**

**Herniated Ovary**

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### Key Findings

5-week-old female presenting with inguinal mass for 1 day with associated increased irritability and decreased p.o. intake.

Grayscale (A and B) and color Doppler (C) ultrasound images of the left groin demonstrate a 1.7 x 0.8 x 1.3 cm oval structure with multiple oval shaped anechoic structures centrally on grayscale images (A and B) at the level of the palpable abnormality. This structure demonstrates internal vascularity on color Doppler image (C). Echotexture and morphology is compatible with a **herniated left ovary**, which was successfully repaired laparoscopically.
Key Findings

74-year-old female with history of non-small cell lung carcinoma. CT of the thorax (A) demonstrates a right infrahilar lung mass (yellow dotted line) compatible with history of lung cancer. Sagittal (B1) and axial (C1) PET images demonstrate a left inguinal hernia containing a focus of mild FDG activity (blue arrow), which corresponds to an enlarged lymph (yellow circle) on sagittal (A2) and axial (B2) CT images. Abnormal FDG activity confirmed on axial non-fused PET image (C3) representing a herniated metastatic lymph node.
59-year-old male with history of papillary urothelial carcinoma. Grayscale (A) and color Doppler (B) ultrasound of the pelvis demonstrated a hyperechoic mass with multiple papillary projections and internal blood flow corresponding to a heterogeneous enhancing bladder mass (yellow circle) on axial contrast-enhanced CT of the pelvis (C). Additional axial (D) and sagittal (E) images demonstrate a right inguinal hernia containing a peripherally enhancing lesion (blue arrow) within the hernia sac is suspicious for metastatic implant.
60-year-old male with history of reducible large right inguinal hernia, referred for possible bowel obstruction. Coronal (A) and sagittal (B) CT abdomen and pelvis images demonstrate a complicated right inguinal hernia containing a large amount of fluid as well as circumferential thick walled loops of sigmoid colon (blue arrows). There is upstream dilation of the colon and small bowel consistent with obstruction. Patient underwent colonoscopy and biopsy, which confirmed sigmoid colon adenocarcinoma within the hernia sac.
**Key Findings**

A follow-up CT of the abdomen and pelvis (A, B, and C) was performed after subsequent colonoscopy and sigmoid colon stent placement. Axial CT image through the level of the kidneys (A) demonstrates free intraperitoneal gas (blue arrow). Axial (B) and sagittal (C) CT of the pelvis demonstrates a large amount of oral contrast (green arrow) pooling within the right inguinal hernia sac as well as a small amount of intraluminal contrast within a loop of sigmoid colon (yellow arrow) extending into the hernia sac. Findings are compatible with colonic perforation.
Key Findings

CT of the abdomen and pelvis (A, B, and C) with oral and IV contrast of the same patient performed 9 days after the diagnosis of bowel perforation demonstrates a large hypodense, peripherally enhancing collection (yellow arrow) along the left anterolateral abdomen extending along the left paracolic gutter into the pelvis and herniates into the right inguinal canal (blue arrows). Findings are compatible with a large abscess herniating into the right inguinal canal.
Inguinal hernias can present in a variety of ways and contain a variety of abdominal and pelvic contents

- The most common contents of inguinal hernias include fat and loops of bowel, but various other pelvic contents have been reported within inguinal hernia sacs

Inguinal hernias can traditionally be diagnosed with physical exam

- However, radiological diagnosis is often necessary for:
  1. Diagnosis of occult hernias
  2. Identification of hernia contents as well as the choice of treatment
  3. Prognostication of patients with complicated inguinal hernias

Ultrasound is frequently the initial diagnostic modality of choice to evaluate uncomplicated inguinal hernias, however, CT and MRI allow better localization and identification of potential complications

Knowledge of inguinal canal anatomy, potential complications, as well as the imaging characteristics of common and uncommon hernia contents is paramount to accurate radiologic interpretation and diagnosis


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