American College of Radiology
ACR Appropriateness Criteria®
Hernia

Variant 1: **Suspected abdominal wall hernia such as umbilical, ventral, incisional, lumbar, or spigelian. Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
US abdomen	Usually Appropriate	O
CT abdomen and pelvis with IV contrast	Usually Appropriate	☢☢☢
CT abdomen and pelvis without IV contrast	Usually Appropriate	☢☢☢
MRI abdomen without and with IV contrast	May Be Appropriate	O
MRI abdomen without IV contrast	May Be Appropriate	O
US pelvis	Usually Not Appropriate	O
Radiography abdomen and pelvis (KUB)	Usually Not Appropriate	☢☢
Fluoroscopy upper GI series	Usually Not Appropriate	☢☢☢
Fluoroscopy upper GI series with small bowel follow-through	Usually Not Appropriate	☢☢☢
MRI pelvis without and with IV contrast	Usually Not Appropriate	O
MRI pelvis without IV contrast	Usually Not Appropriate	O
CT abdomen and pelvis without and with IV contrast	Usually Not Appropriate	☢☢☢☢

Variant 2: **Suspected groin hernia such as inguinal or femoral. Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
US pelvis	Usually Appropriate	O
MRI pelvis without and with IV contrast	Usually Appropriate	O
CT abdomen and pelvis with IV contrast	Usually Appropriate	☢☢☢
CT abdomen and pelvis without IV contrast	Usually Appropriate	☢☢☢
CT pelvis with IV contrast	Usually Appropriate	☢☢☢
CT pelvis without IV contrast	Usually Appropriate	☢☢☢
MRI pelvis without IV contrast	May Be Appropriate	O
Radiography abdomen and pelvis (KUB)	Usually Not Appropriate	☢☢
Fluoroscopy small bowel follow-through	Usually Not Appropriate	☢☢☢
CT abdomen and pelvis without and with IV contrast	Usually Not Appropriate	☢☢☢☢
CT pelvis without and with IV contrast	Usually Not Appropriate	☢☢☢☢

Variant 3: **Suspected deep pelvic hernia including obturator, sciatic, or perineal. Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
MRI pelvis without and with IV contrast	Usually Appropriate	O
CT abdomen and pelvis with IV contrast	Usually Appropriate	☢☢☢
CT abdomen and pelvis without IV contrast	Usually Appropriate	☢☢☢
CT pelvis with IV contrast	Usually Appropriate	☢☢☢
CT pelvis without and with IV contrast	Usually Appropriate	☢☢☢☢
MRI pelvis without IV contrast	May Be Appropriate	O
US pelvis	Usually Not Appropriate	O
Radiography abdomen and pelvis (KUB)	Usually Not Appropriate	☢☢
Fluoroscopy small bowel follow-through	Usually Not Appropriate	☢☢☢
CT abdomen and pelvis without and with IV contrast	Usually Not Appropriate	☢☢☢☢
CT pelvis without IV contrast	Usually Not Appropriate	☢☢☢

Variant 4: **Suspected diaphragmatic hernia including traumatic, Bochdalek, or Morgagni. Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
CT chest and abdomen with IV contrast	Usually Appropriate	☢☢☢☢
CT chest and abdomen without IV contrast	Usually Appropriate	☢☢☢☢
Radiography chest	May Be Appropriate	☢
Fluoroscopy upper GI series	May Be Appropriate	☢☢☢
MRI chest and abdomen without and with IV contrast	May Be Appropriate	O
MRI chest and abdomen without IV contrast	May Be Appropriate	O
US abdomen	Usually Not Appropriate	O
Radiography abdomen and pelvis (KUB)	Usually Not Appropriate	☢☢
Fluoroscopy upper GI series with small bowel follow-through	Usually Not Appropriate	☢☢☢
CT chest and abdomen without and with IV contrast	Usually Not Appropriate	☢☢☢☢

HERNIA

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Summary of Literature Review

Introduction/Background

Abdominal wall hernias are common clinical entities presenting to a wide variety of clinical practices, from primary care to the emergency department. Presenting symptoms vary, including vague discomfort, intractable pain, or a palpable mass, which may be persistent or intermittent, symptoms of bowel obstruction, abdominal wall erythema, or it may be occult. Up to 15.2% of hernias are identified incidentally at imaging [1]. Hernias may be congenital, iatrogenic, traumatic, or related to any of the multiple causes of elevated intraabdominal pressure.

The initial imaging in four hernia categories are covered in this document: 1) suspected abdominal wall hernia, such as umbilical, ventral, incisional, lumbar, spigelian; 2) suspected groin hernia, such as inguinal or femoral; 3) suspected deep pelvic hernia such as obturator, sciatic, perineal hernias; and 4) suspected diaphragmatic hernia such as traumatic, Bochdalek, or Morgagni. Imaging diagnosis of hiatal hernias is not included in this document.

Special Imaging Considerations

Sport Hernias and Internal Hernias: Although the focus of this document is abdominal wall hernias, it is important to mention sport and internal hernias, because these entities are becoming more prevalent. With the expansion of high-level sporting opportunities and the increasing length of seasons for amateur and professional leagues, increasing numbers of individuals are presenting with activity related groin pain. It is important to realize that "sport hernias" (or athletic pubalgia) are not true hernias and represent unilateral groin pain in the absence of a demonstrable hernia.

With the increasing frequency and expanding techniques of bariatric surgery, 4 specific types of internal hernias related to these procedures are becoming more commonly recognized [2]. Symptoms of bowel obstruction and nonspecific abdominal pain are common presentations, and readers should refer to ACR Appropriateness Criteria® topics on "Suspected Small-Bowel Obstruction" [3] and "Acute Nonlocalized Abdominal Pain" [4].

Initial Imaging Definition

Initial imaging is defined as imaging at the beginning of the care episode for the medical condition defined by the variant. More than one procedure can be considered usually appropriate in the initial imaging evaluation when:

- There are procedures that are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care)

OR

- There are complementary procedures (ie, more than one procedure is ordered as a set or simultaneously in which each procedure provides unique clinical information to effectively manage the patient's care).

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Discussion of Procedures by Variant

Variant 1: Suspected abdominal wall hernia such as umbilical, ventral, incisional, lumbar, or spigelian. Initial imaging.

Surgical procedures create measurable alterations in the abdominal wall, which may be identified and quantified with cross-sectional imaging [5]. Shifts in relative position and atrophy of musculature are identified and may contribute to the development of incisional hernias. Abdominal wall hernias may be challenging to diagnose clinically and are prone to complications if not addressed in a timely fashion [6]. Diagnosis and presurgical planning may be achieved through several imaging modalities.

Spigelian hernia is a rare form of hernia, occurring through a defect adjacent to the linea semilunaris with a reported incidence of 0.12% of all abdominal hernias [7]. They may be congenital, secondary to high-energy trauma such as motor vehicle collisions, or found in high-level athletes [8]. Presenting signs and symptoms may be vague and nonspecific. Clinical examination has demonstrated high sensitivity of 100%, but a poor positive predictive value (PPV) at 36% [9].

Primary lumbar hernias are protrusions of the abdominal contents through the superior or inferior lumbar triangles. The first branches of the iliolumbar vessels may pass through the superior triangle, found in 46% of patients in a series of 50 upper abdominal CTs evaluating triangle anatomy [10]. The second, third, and fourth lumbar nerve branches may traverse the inferior triangle and were found in 9%, 67%, and 8%, respectively. These anatomic channels may contribute to the development of hernias because they represent natural weak points in the abdominal wall.

Umbilical hernia is a common abdominal wall defect because the healed site of traverse of the umbilical vasculature represents a congenital abdominal wall weak point. Umbilical hernias are associated with causes of increased intraabdominal pressure. Among these causes are ascites, bland and malignant, and masses [11,12]. Ascites volume in cirrhotic patients was positively associated with development of umbilical hernias ($P < .0001$, $r = 0.4579$). In many cases, umbilical hernias become apparent during pregnancy. An ultrasound (US) examination of the abdominal wall in a series of 302 patients referred for unrelated reasons yielded a prevalence of paraumbilical hernia in 24.9% of women and 23.3% of men [13]. Diastasis recti, weakened linea alba without disruption, may have a similar presentation. If possible, width should be measured and reported.

Clinically, incisional hernia is defined as a detectable abdominal wall defect following surgical intervention with protrusion of abdominal contents or preperitoneal fat beyond the aponeurosis. Incidence is variable and related to patient characteristics and procedure. The rate of occurrence in laparoscopic procedures were as low as 2% [14]. However, the increased size of the fascial defect predisposes to increased incidence of port-site hernias. In a retrospective review of 787 patients who underwent single-incision laparoscopic procedures, Buckley et al [15] found that 2% to 6.35% developed port-site incisional hernias. Risk factors found to be associated with increased likelihood of developing an incisional hernia included pre-existing hernia ($P = .00212$), body mass index ($P = .0307$), and morbid obesity ($P = .02$). In a series of 589 patients who underwent abdominal free flap reconstruction, Kappos et al [16] found symptomatic incisional hernias were significantly associated to low rectus abdominis muscle area, obtained through morphometric measurements on preoperative CT angiograms, and increased interrectus distance.

Parastomal hernias are a specific type of incisional hernia seen most often in oncology patients. Rate of occurrence of parastomal hernias were found up to 65% in ileal conduits [17], and 30% to 50% of colostomies [18]. The majority of parastomal hernias in permanent colostomy patients occur within the first 2 years [19]. Complications include pain, stoma obstruction, bowel obstruction, and strangulation. Because the stoma itself is effectively an iatrogenic hernia, with a specific clinical purpose and necessary disruption of abdominal wall integrity, clinical diagnosis is difficult with interobserver kappa values of 0.29 to 0.73 [20].

Umbilical hernia is a common abdominal wall defect because the healed site of traverse of the umbilical vasculature represents a congenital abdominal wall weak point. Umbilical hernias are associated with causes of increased intraabdominal pressure. Among these causes are ascites, bland and malignant, and masses [11,12]. Ascites volume in cirrhotic patients was positively associated with development of umbilical hernias ($P < .0001$, $r = 0.4579$). An ultrasound (US) examination of the abdominal wall in a series of 302 patients referred for unrelated reasons yielded a prevalence of paraumbilical hernia in 24.9% of women and 23.3% of men [13]. Diastasis recti, weakened linea alba without disruption, may have a similar presentation. If possible, width should be measured and reported.

CT Abdomen and Pelvis

Incidence of incisional hernia of 33% was found by Bjork et al [21] with clinical examination yielding a Kappa of 0.81 and CT yielding Kappas of 0.94 and 0.89, respectively, for supine and prone positioning. In one series with surgical confirmation, CT demonstrated high sensitivity and PPV, both at 100%, in diagnosis of Spigelian hernia [9]. Stoma closure sites are common incisional weak points in the abdominal wall. CT demonstrates a low PPV of 33% with a high negative predictive value (NPV) of 95% in the diagnosis of parastomal hernia [22]. This compares favorably with a clinical detection rate of 14%. There are no specific data differentiating diagnostic efficacy of intravenous (IV) contrast versus noncontrast examination. There are no specific data regarding the use of CT without and with IV contrast, but theoretically, the additional information gained between comparison of a noncontrast and postcontrast series would not be beneficial for hernia detection and characterization.

Fluoroscopy Upper GI Series

There is no relevant literature regarding the use of fluoroscopy upper gastrointestinal (GI) series in the evaluation of abdominal wall hernia.

Fluoroscopy Upper GI Series with Small Bowel Follow-Through

Anterior abdominal wall hernia may be diagnosed with fluoroscopic studies. Barium is the most common contrast employed. Hernias are recognized when bowel loops are seen extending beyond the fascial planes, focal luminal narrowing at entry and/or exit sites, and displacement or deformity of bowel loops [23]. No specific data are available relative to the sensitivity, specificity, or accuracy of upper GI with small bowel follow-through in the diagnosis of abdominal wall hernias.

MRI Abdomen Without and With IV Contrast

There is no relevant literature regarding the use of MRI abdomen in the evaluation of abdominal wall hernia. However, the modality would be able to depict the anatomy, and theoretically, visualize a hernia. The specific performance attributes are unknown.

MRI Abdomen Without IV Contrast

There is no relevant literature regarding the use of MRI abdomen in the evaluation of abdominal wall hernia. However, the modality would be able to depict the anatomy, and theoretically, visualize a hernia. The specific performance attributes are unknown.

MRI Pelvis

There is no relevant literature regarding the use of MRI pelvis in the evaluation of abdominal wall hernia. However, the modality would be able to depict the anatomy, and theoretically, visualize a hernia. The specific performance attributes are unknown.

Radiography Abdomen and Pelvis (KUB)

There is no relevant literature regarding the use of radiography abdomen and pelvis (KUB) in the evaluation of abdominal wall hernia. However, there may be utility if there is concern for bowel obstruction.

US Abdomen

US has long been used in the evaluation of the palpable abdominal masses. The ability to differentiate the abdominal wall from intraabdominal processes and distinguish the abdominal wall layers is well established. Use of high-frequency transducers and dynamic maneuvers frequently demonstrate the fascial defect and herniated abdominal structures with their characteristic US features [24]. In a case series with surgical confirmation of presence of Spigelian hernia, US demonstrated a sensitivity of 90% and a PPV of 100% [9]. Dynamic US demonstrated a high sensitivity, specificity, PPV, and NPV of 98%, 88%, 91%, and 97%, respectively, in the diagnosis of incisional hernias in a prospective study of 181 patients. Patients with stoma, fistula, and/or abdominal wall infection were excluded [25].

US Pelvis

There is no relevant literature regarding the use of US pelvis in the evaluation of abdominal wall hernia.

Variant 2: Suspected groin hernia such as inguinal or femoral. Initial imaging.

Inguinal hernias are common entities. Clinical diagnosis and differentiation of direct inguinal, indirect inguinal, and femoral hernias may be difficult. These hernias present in similar fashion with bulge, pain, and potentially signs and symptoms of bowel obstruction. In addition, the hernia may be occult, presenting with groin or pelvic pain in the absence of a palpable bulge or any other typical clinical examination findings. They may also present as an incidental finding in patients with athletic pubalgia or chronic pain following herniorrhaphy [26,27]. Imaging techniques provide visualization of the key anatomic landmarks and the relative position of herniated tissues, allowing differentiation of these entities. In addition, the impact of herniated tissues on the adjacent structures such as compression of the femoral vein in femoral hernia may be identified, aiding specific diagnosis [28].

Femoral hernia is uncommon, typically diagnosed in an older population, and as with the more common inguinal hernias, may present with groin pain, a lump, or symptoms of bowel obstruction. Diagnosis is important because ischemia and perforation are complications which tend to be more serious in this population. In a series of 86 patients diagnosed with femoral hernia, 9.3% required intestinal resection [29]. De Garengeot's hernia is a special form of femoral hernia containing the acutely inflamed appendix. A literature review of English language articles produced presentation frequencies of right groin mass in 97%, with pain in 97%, and fever in 39% [30].

CT Abdomen and Pelvis

For the diagnosis of occult inguinal hernia, performance of CT demonstrated sensitivities of 54% to 80% and specificities of 25% to 65% [31,32]. In a meta-analysis, CT was diagnostic in 44% of patients with De Garengeot's hernia compared with 20% by US. There are no specific data differentiating diagnostic efficacy of an IV contrast versus noncontrast examination. There are no specific data regarding the use of CT without and with IV contrast, but theoretically, the additional information gained between comparison of a noncontrast and postcontrast series would not be beneficial for hernia detection and characterization.

CT Pelvis

In a single prospective study, specifically evaluating CT imaging limited to the lower abdomen and pelvis evaluated prone patient positioning for hernia specific CT, there were 914 patients included in this prospective study and surgery was the reference standard. A prone CT protocol yielded an accuracy rate of 95.8% [33]. There are no specific data regarding the use of CT without and with IV contrast, but theoretically, the additional information gained between comparison of a noncontrast and postcontrast series would not be beneficial for hernia detection and characterization.

Fluoroscopy Small Bowel Follow-Through

There is no relevant literature regarding the use of fluoroscopy small bowel follow-through in the evaluation of groin, inguinal, or femoral hernia. However, the modality would be able to depict the anatomy and, theoretically, visualize a hernia. The specific performance attributes are unknown.

MRI Pelvis

MRI is useful and can help visualize anatomic structures. In a retrospective review of 36 patients with suspected occult inguinal hernia, MRI demonstrated a sensitivity, a specificity, a PPV, and an NPV of 91%, 92%, 95%, and 85%, respectively, correctly diagnosing hernia in 10 of 11 patients [32]. In a retrospective review of 117 athletes who underwent MRI for groin pain, inguinal hernia was diagnosed in 35% of patients [26]. There are no specific data differentiating diagnostic efficacy of IV contrast versus noncontrast examination.

Radiography Abdomen and Pelvis (KUB)

In case series of 170 and 204 herniographies for diagnosis of occult groin hernia, 49% and 35% were positive, respectively [34,35]. However, in the Ward et al study [35], 6 of 41 patients undergoing surgical repair, 16% were found to not have a hernia in the series. Whereas, in the Hachem et al study [34], all 84 patients with positive herniogram had hernia confirmed at surgery. In a third series of patients suspected of having occult inguinal hernia, herniography was found to have a sensitivity and specificity of 91% and 83%, respectively [31].

US Pelvis

Diagnostic performance of US is common in the diagnosis of occult inguinal hernia. In a retrospect analysis of 297 patients, 116 went on to surgery. Based on surgical findings, US had a sensitivity of 94% with a PPV of 73% [36]. When US was performed by musculoskeletal experts, US had a sensitivity of 96.3% [37].

Another retrospective review of 375 symptomatic patients with 118 referred on to surgery, the PPV for US was 70% (95%, confidence interval [CI]: 62%–78%) [38]. A German retrospective study found a sensitivity, a specificity, a PPV, and an NPV for US of 97%, 77%, 95%, and 87%, respectively [39].

Two meta-analyses of US performance yielded sensitivities of 29.4% (95% CI: 15.1%–47.5%) and 90.9% (95% CI: 70.8%–98.9%) and 92.7% to 100%, specificities of 90.0% (95% CI: 80.5%–95.9%) and 90.6% (95% CI: 83%–95.6%) and 22.2% to 100%. PPV ranged from 58.8% to 100% and 83.3% to 100% with a pooled PPV of 85.6% (95% CI: 76.5%–92.7%) [40,41]. Performance in diagnosis of patients with a groin hernia suspected on clinical examination yielded a sensitivity and specificity of 96% [42]. In a case series of 18 consecutive pregnant patients with groin pain and swelling with clinical suspicion of hernia, hernia was not present in any patient and symptoms resolved following delivery [43]. Color Doppler US was positive for enlarged veins around the round ligament.

A retrospective review of clinical and imaging data for 93 patients referred for sonographic evaluation of suspected femoral hernia before surgery, 55 underwent surgery, US was found to have a sensitivity, a specificity, a PPV, and an NPV of 80%, 88%, 71%, and 92%, respectively [44]. In a prospective evaluation of US, high-frequency linear transducers were found to have a sensitivity and a specificity for diagnosis of femoral and small/occult groin hernias of 97.58% and 99.8%, respectively [45]. US was diagnostic in 20% of patients with De Garengeot's hernia [30].

Variant 3: Suspected deep pelvic hernia including obturator, sciatic, or perineal. Initial imaging.

Deep pelvis hernias are exceedingly rare, and little current literature is available, with the majority addressing obturator hernias and primarily case reports for the other entities. Obturator hernias comprise <1% of hernias [46]. Presenting symptoms are vague and varied and may be completely absent. Signs and symptoms include small-bowel obstruction (63%), vague and/or intractable abdominal/groin pain (57%), palpable medial thigh lump (10%), and thigh pain referred to the knee (37%) [46-48]. Referred pain is secondary to compression of the obturator nerve within the obturator foramen. Elderly women are most commonly affected, and diagnosis is most commonly made at surgery, often for inguinal hernia repair [47,49].

In a case series by Light et al [49] of 30 patients, 5 patients were suspected to have obturator hernia on clinical examination alone, with only 3 confirmed surgically. Because of the lack of specific symptoms and signs in the primarily elderly population, diagnosis is often delayed with significant morbidity (30%) and mortality (10%), with small-bowel resection performed in 47% of patients in one study [46,47]. Nasir et al [47], in a retrospective review, demonstrated diagnosis preoperatively in only 30% of patients, 3% clinically, and 27% with CT.

Sciatic hernias may occur through the greater or lesser sciatic foramina. Presenting signs and symptoms include gluteal mass, nonspecific pelvic pain, back pain, bowel and bladder urgency, and obstructive symptoms referable to the system involved, GI or genitourinary [50]. Occult sciatic hernias may be present concomitantly with obturator hernias. In a retrospective review of 38 patients with new onset obturator hernia examined with multidetector CT [51], sciatic hernias were found in 24%. Hernia patients were found to have a significantly lower body mass index of 17.2 ± to 2.4 kg/m^2 versus 19.6 ± 2.6 kg/m^2 than those without (P = .02).

Perineal hernias may be congenital or acquired. They are classified as anterior or posterior based on relative position to the superficial transverse perineal muscle [52]. Acquired perineal hernias are rare surgical complications, most often associated with oncologic surgeries for colorectal and genitourinary neoplasm such as abdominoperineal resection and cystectomy. Postprocedural pelvic floor weakening is implicated [53].

CT Abdomen and Pelvis

Preoperative CT is excellent in diagnosing obturator hernia, although the diagnosis is seldom suspected, most often incidentally identified at abdominal pelvic imaging for the diagnosis of small-bowel obstruction. Nasir et al [47], in a retrospective review, found that patients diagnosed with obturator hernia on preoperative CT are less likely to develop postoperative complications (odds ratio: 0.8, P = .04). Preoperative diagnosis did not impact length of stay, bowel resection, or mortality rates. CT has also been found to be efficacious in the diagnosis of sciatic and perineal hernias [51,53]. Because of the infrequency of these entities and the majority of literature being in the form of case reports, sensitivities, specificities, and accuracy ranges are not available. There are no specific data differentiating diagnostic efficacy of an IV contrast versus noncontrast examination. There are no specific data regarding the use of CT without and with IV contrast, but theoretically, the additional information gained between comparison of a noncontrast and postcontrast series would not be beneficial for hernia detection and characterization.

CT Pelvis

Retrospective reviews of clinical databases regarding imaging diagnosis of these rare deep pelvic hernias do not separate abdominal pelvic CT from pelvic CT alone [47,51,53]. Depending upon the area of coverage, CT pelvis can be useful in diagnosis and pre-operative planning. There are no specific data differentiating diagnostic efficacy of an IV contrast versus noncontrast examination. There are no specific data regarding the use of CT without and with IV contrast, but theoretically, the additional information gained between comparison of a noncontrast and postcontrast series would not be beneficial for hernia detection and characterization. Of note, CT without and with IV contrast is not typically performed for this scenario.

Fluoroscopy Small Bowel Follow-Through
There is no relevant literature regarding the use of small bowel follow-through in the evaluation of deep pelvic hernia. However, demonstration of abnormal bowel configuration suggesting herniation may be helpful in complex cases.

MRI Pelvis
No specific data are available relative to the sensitivity, specificity, or accuracy of MRI in the diagnosis of deep pelvic hernias. However, case reports demonstrate efficacy, particularly in patients with orthopedic instrumentation limiting CT imaging [54]. There are no specific data differentiating diagnostic efficacy of IV contrast versus noncontrast examination. However, the modality would be able to depict the anatomy, and theoretically, visualize a hernia. The specific performance attributes are unknown.

Radiography Abdomen and Pelvis (KUB)
There is no relevant literature regarding the use of KUB in the evaluation of deep pelvic hernia. However, there may be utility if there is a concern for bowel obstruction.

US Pelvis
There is no relevant literature regarding the use of US of the pelvis in the evaluation of deep pelvic hernia.

Variant 4: Suspected diaphragmatic hernia including traumatic, Bochdalek, or Morgagni. Initial imaging.

Diaphragmatic hernias are rare and diagnosis may be difficult despite high-resolution multiplanar imaging techniques. Congenital, traumatic, and iatrogenic etiologies are evaluated primarily with CT and MRI. Congenital, Bochdalek and Morgagni hernias are most often diagnosed in the prenatal or neonatal period because of abnormalities detected on obstetric US. Diagnosis of traumatic diaphragmatic rupture with herniation of abdominal contents into the thorax is often delayed because of subtle initial imaging findings and late herniation of abdominal contents into the thorax.

Congenital diaphragmatic hernias are rare, occurring in approximately 1 per 2,000 pregnancies with 5% Morgagni and 90% Bochdalek hernias [55]. Most are diagnosed on prenatal imaging and present in the neonatal period with cardiorespiratory compromise and are surgically corrected. Bochdalek hernias are the result of improper fusion of the septum transversarium and pleuroperitoneal folds and are present in 1:2,200 to 12,500 live births [56,57]. Morgagni hernia is a defect in the anterior diaphragm between the costal and sternal portions of the muscle [58]. Adult presentation is uncommon and usually an incidental finding on imaging performed for unrelated reasons.

Retrospective review series of multidetector CT performed for unrelated indications identified Bochdalek hernia in 10.5% to 12.7% of adults [59,60]. However, these hernias may also present with acute symptoms related to complications of obstruction, perforation, or necrosis of the herniated organs [56,61-63].

CT Chest and Abdomen
CT is an efficacious method for the diagnosis of traumatic diaphragmatic hernia with a sensitivity, a specificity, a PPV, an NPV, and an accuracy ranging from 56.5% to 82%, 69.6% to 100%, 69% to 100%, 88.4% to 93%, and 89% to 90.6%, respectively [64-66].

For the diagnosis of congenital hernia, there is particular emphasis on the utility of multiplanar technique [59-63,67-69]. Data on sensitivity, specificity, and accuracy are not available because the majority of literature is comprised of case reports. There is no specific data differentiating diagnostic efficacy of IV contrast versus noncontrast examination. There is no specific data regarding the use of CT without and with IV contrast, but theoretically, the additional information gained between comparison of a noncontrast and postcontrast series would not be beneficial for hernia detection and characterization.

Fluoroscopy Upper GI Series
Upper GI diagnosed congenital diaphragmatic hernia in one case report of Morgagni hernia [61], and contrast swallow was diagnostic on one reported case of Bochdalek hernia [63].

Fluoroscopy Upper GI Series with Small Bowel Follow-Through
There is no relevant literature regarding the use of fluoroscopy upper GI series with small bowel follow-through in the evaluation of diaphragmatic hernia. However, demonstration of abnormal bowel configuration suggesting herniation may be helpful in complex cases.

MRI Chest and Abdomen
MRI was a diagnostic method in one case series of 10 patients with delayed presentation of traumatic diaphragmatic herniation. No performance data are provided [70]. Primary indication in the Eren and Ciris case review [67] is for problem-solving in delayed presentation of traumatic diaphragmatic hernia. MRI was employed in the diagnosis of cases of Morgagni and Bochdalek hernias [67,69]. There are no specific data differentiating diagnostic efficacy of IV contrast versus noncontrast examination.

Radiography Abdomen and Pelvis (KUB)
There is no relevant literature regarding the use of KUB in the evaluation of diaphragmatic hernia. However, there may be utility if there is concern for obstruction.

Radiography Chest
Chest radiography is noted to be of value in the diagnosis of diaphragmatic hernia, being diagnostic in 50% to 81.3% of traumatic hernia patients [71,72]. It was also diagnostic in multiple congenital diaphragmatic hernia case reports [60-63,67,68]. Data on sensitivity, specificity, and accuracy are not available because of the rarity of these hernias.

US Abdomen
Abdominal US is used in the setting of trauma for visualization of the thoracoabdominal structures to identify evidence of traumatic injuries [67]. Performance data were not provided.

Summary of Recommendations

- **Variant 1**: US abdomen or CT abdomen and pelvis with IV contrast or CT abdomen and pelvis without IV contrast is usually appropriate as the initial imaging of suspected abdominal wall hernia such as umbilical, ventral, incisional, lumbar, or spigelian. These procedures are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care).

- **Variant 2**: US pelvis or MRI pelvis without and with IV contrast or CT abdomen and pelvis with IV contrast or CT abdomen and pelvis without IV contrast or CT pelvis with IV contrast or CT pelvis without IV contrast is usually appropriate as the initial imaging of suspected groin hernia such inguinal or femoral. These procedures are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care).

- **Variant 3**: MRI pelvis without and with IV contrast or CT abdomen and pelvis with IV contrast or CT abdomen and pelvis without IV contrast or CT pelvis with IV contrast or CT pelvic without IV contrast is usually appropriate as the initial imaging of suspected deep pelvic hernia including obturator, sciatic, or perineal. These procedures are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care).

- **Variant 4**: CT chest and abdomen with IV contrast or CT chest and abdomen without IV contrast is usually appropriate as the initial imaging of suspected diaphragmatic hernia including traumatic, Bochdalek, or Morgagni. These procedures are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care).

Supporting Documents

The evidence table, literature search, and appendix for this topic are available at https://acsearch.acr.org/list. The appendix includes the strength of evidence assessment and the final rating round tabulations for each recommendation.

For additional information on the Appropriateness Criteria methodology and other supporting documents go to www.acr.org/ac.

Appropriateness Category Names and Definitions

Appropriateness Category Name	Appropriateness Rating	Appropriateness Category Definition
Usually Appropriate	7, 8, or 9	The imaging procedure or treatment is indicated in the specified clinical scenarios at a favorable risk-benefit ratio for patients.
May Be Appropriate	4, 5, or 6	The imaging procedure or treatment may be indicated in the specified clinical scenarios as an alternative to imaging procedures or treatments with a more favorable risk-benefit ratio, or the risk-benefit ratio for patients is equivocal.
May Be Appropriate (Disagreement)	5	The individual ratings are too dispersed from the panel median. The different label provides transparency regarding the panel's recommendation. "May be appropriate" is the rating category and a rating of 5 is assigned.
Usually Not Appropriate	1, 2, or 3	The imaging procedure or treatment is unlikely to be indicated in the specified clinical scenarios, or the risk-benefit ratio for patients is likely to be unfavorable.

Relative Radiation Level Information

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Patients in the pediatric age group are at inherently higher risk from exposure, because of both organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared with those specified for adults (see Table below). Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® Radiation Dose Assessment Introduction document [73].

Relative Radiation Level Designations		
Relative Radiation Level*	**Adult Effective Dose Estimate Range**	**Pediatric Effective Dose Estimate Range**
O	0 mSv	0 mSv
☢	<0.1 mSv	<0.03 mSv
☢☢	0.1-1 mSv	0.03-0.3 mSv
☢☢☢	1-10 mSv	0.3-3 mSv
☢☢☢☢	10-30 mSv	3-10 mSv
☢☢☢☢☢	30-100 mSv	10-30 mSv

*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (eg, region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as "Varies."

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