American College of Radiology
ACR Appropriateness Criteria®

Palpable Abdominal Mass-Suspected Neoplasm

Variant: 1 Palpable abdominal mass. Suspected intra-abdominal neoplasm. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
US abdomen	Usually Appropriate	O
CT abdomen with IV contrast	Usually Appropriate	☢☢☢
MRI abdomen without and with IV contrast	May Be Appropriate	O
MRI abdomen without IV contrast	May Be Appropriate	O
CT abdomen without IV contrast	May Be Appropriate	☢☢☢
Radiography abdomen	Usually Not Appropriate	☢☢
Fluoroscopy contrast enema	Usually Not Appropriate	☢☢☢
Fluoroscopy upper GI series	Usually Not Appropriate	☢☢☢
Fluoroscopy upper GI series with small bowel follow-through	Usually Not Appropriate	☢☢☢
CT abdomen without and with IV contrast	Usually Not Appropriate	☢☢☢☢
FDG-PET/CT skull base to mid-thigh	Usually Not Appropriate	☢☢☢☢

Variant: 2 Palpable abdominal mass. Suspected abdominal wall mass. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
US abdomen	Usually Appropriate	O
MRI abdomen without and with IV contrast	Usually Appropriate	O
CT abdomen with IV contrast	Usually Appropriate	☢☢☢
MRI abdomen without IV contrast	May Be Appropriate	O
CT abdomen without IV contrast	May Be Appropriate	☢☢☢
Radiography abdomen	Usually Not Appropriate	☢☢
Fluoroscopy contrast enema	Usually Not Appropriate	☢☢☢
Fluoroscopy upper GI series	Usually Not Appropriate	☢☢☢
Fluoroscopy upper GI series with small bowel follow-through	Usually Not Appropriate	☢☢☢
CT abdomen without and with IV contrast	Usually Not Appropriate	☢☢☢☢
FDG-PET/CT skull base to mid-thigh	Usually Not Appropriate	☢☢☢☢

Panel Members

Kathryn J. Fowler, MD[1]; Evelyn M. Garcia, MD[b]; David H. Kim, MD[c]; Brooks D. Cash, MD[d]; Kevin J. Chang, MD[e]; Barry W. Feig, MD[f]; Kenneth L. Gage, MD, PhD[g]; Avinash R. Kambadakone, MD[h]; Angela D. Levy, MD[i]; Peter S. Liu, MD[j]; Daniele Marin, MD[k]; Courtney Moreno, MD[l]; Christine M. Peterson, MD[m]; Jason A. Pietryga, MD[n]; Martin P. Smith, MD[o]; Laura R. Carucci, MD.[p]

Summary of Literature Review

Introduction/Background

Pathology associated with palpable masses in adult patients is extensive, and subcategorization is

often helpful. Palpable abdominal masses can often be characterized by physical examination as arising from the abdominal cavity or abdominal wall. The differential diagnosis for each location is broad. For abdominal cavity masses, the differential includes neoplasms from a solid organ or viscera and abdominal aortic aneurysms. Additionally, distension from constipation, bowel obstruction, or volvulus may present as a palpable mass. For abdominal wall masses, considerations include lipomas, hematomas, lymph nodes, endometriomas, and hernias. This article focuses on palpable masses arising in the abdominal region. The imaging approach to soft-tissue masses in the extremities is also covered in the ACR Appropriateness Criteria® on "Soft-Tissue Masses" [1]. Evaluation of pulsatile abdominal mass is discussed in the ACR Appropriateness Criteria® on "Pulsatile Abdominal Mass, Suspected Abdominal Aortic Aneurysm" [2]. Evaluation of suspected pelvic mass in female patients is discussed in the ACR Appropriateness Criteria® on "Clinically Suspected Adnexal Mass, No Acute Symptoms" [3]. Palpable abdominal masses in pediatric patients present unique differential diagnoses and require further imaging consideration. This article only includes the workup of palpable masses in adult patients.

Discussion of Procedures by Variant

Variant 1: Palpable abdominal mass. Suspected intra-abdominal neoplasm. Initial imaging.

Little has been written about the use of imaging in evaluating palpable abdominal masses since the 1980s. Newer reviews and case reports have focused on evaluation of specific masses using CT, ultrasound (US), and MRI. Radiography of the abdomen and fluoroscopy play a limited role in the diagnosis and workup of a palpable intra-abdominal mass.

Variant 1: Palpable abdominal mass. Suspected intra-abdominal neoplasm. Initial imaging. A. CT Abdomen

There have been no recent studies on the diagnostic yield of CT for abdominal masses; however, it is widely used and assumed to be accurate in patients presenting with varying pathologies that may cause an abdominal mass [4-7]. Most data on diagnostic accuracy stem from studies that are >30 years old. In a controlled trial from 1981 by Dixon et al [8], CT established diagnosis more quickly and reduced inpatient workup times in patients with abdominal masses when compared against conventional radiography and workup. In another study from 1984 by Williams et al [9], CT demonstrated high positive predictive value (99%) and negative predictive value (97%) for determining the presence or absence of a mass and correctly identified the organ of origin in 93% of patients with palpable abnormalities on clinical examination. The Dixon et al [8] study demonstrated that, compared with strategies not using CT, the use of CT can result in savings in time for diagnosis. Accordingly, when US findings are indeterminate, CT imaging should be obtained in a timely manner.

Organomegaly (ie, enlargement of the liver, spleen, or kidneys), may present with a palpable mass. The differential diagnosis is lengthy, including lymphoma, primary organ disease, metastatic disease, extramedullary hematopoiesis, granulomatous disease, and infections. CT can provide clues to help narrow the differential diagnosis, although biopsy is often warranted [6,10]. CT is considered safe and effective for guiding percutaneous biopsies if the pathology can be visualized and the operator has knowledge of technical parameters, such as the need for breath holding, triangulation methods, gantry angling, and appropriate patient positioning [11-13]. There are no recent studies that specifically address the question of whether CT should be performed with or without intravenous (IV) contrast for a palpable mass. Acquisition of CT both with and without contrast does not generally add diagnostic value. Although available evidence and experience

generally supports the appropriateness of CT with IV contrast over that of noncontrast CT for evaluation of intra-abdominal organs and pathology [12,14,15], the use of noncontrast CT may be of value in some circumstances.

Variant 1: Palpable abdominal mass. Suspected intra-abdominal neoplasm. Initial imaging. B. US Abdomen

US has many positive attributes and is a useful tool for detecting and diagnosing potential intra-abdominal masses [4-6,16-19]. In a retrospective study including 104 patients with palpable masses referred for US evaluation, 69 had a correlative mass and US correctly identified the organ of origin in 88% of patients [17]. The 3 cases where the organ of origin was not positively identified were all masses arising in the pelvis (endometriosis, uterine fibroids, and ovarian tumor), which were later defined on CT. Despite the failure in these cases, the positive predictive value was 99% and negative predictive value 97% for identifying or excluding a mass. The one false-negative case was a patient with palpable mass on examination who had a negative US but subsequently positive CT demonstrating transverse colon cancer. The accuracy for identifying the organ of origin ranges from 88% to 91%, and 77% to 81% for correctly suggesting the underlying pathology [16,17,20,21].

Although highly accurate, US visibility of the abdominal cavity may be limited because of bowel gas and body habitus. On the other hand, US has the benefit of real-time imaging. This can be very advantageous in the setting of palpable abnormality, providing additional information, such as tenderness, direct correlation, and dynamic changes like Valsalva maneuvers, when assessing for hernias. Studies have suggested that portable US units may improve diagnostic accuracy for detecting organomegaly [22] and may help to determine the need for additional diagnostic testing with a sensitivity of 91% and specificity of 83% [23]. US is considered highly useful for real-time guidance for biopsy and establishing definitive diagnosis [11,12].

Variant 1: Palpable abdominal mass. Suspected intra-abdominal neoplasm. Initial imaging. C. MRI Abdomen

No comparative studies are available in the literature; however, there are several potential advantages to MRI that may advocate for its use in some instances. MRI possesses very high soft-tissue contrast, allowing depiction and differentiation of cystic structures, soft-tissue components, fat, and blood products [10]. This can be especially useful for defining benign from malignant lesions in organs such as the adrenal glands, kidneys, ovaries, and liver. Although MRI offers potential advantages, its exact performance in evaluating palpable masses relative to US and CT remains unclear given the absence of data; however, it is likely at least comparable. Although not always a first-line option, MRI can be very useful as a second-line imaging modality to further evaluate indeterminate masses detected on CT or US. Similar to CT, there is no evidence evaluating the utility and added benefit of IV contrast versus noncontrast MRI in the setting of a palpable intra-abdominal mass. Experience and evidence related to solid organ evaluation (liver, pancreas, and kidneys) suggests that IV contrast improves visualization of normal organs and pathology. However, there is some value in noncontrast MRI as it may still depict soft-tissue structures and delineate a mass.

Variant 1: Palpable abdominal mass. Suspected intra-abdominal neoplasm. Initial imaging. D. Radiography Abdomen

Radiography is often not sufficient as a first step in evaluation of a palpable mass and hence the acquisition of cross-sectional imaging would likely be required for diagnosis regardless of the results of the radiograph [24,25]. Radiography may also be considered as a first step in rare

situations. If the patient reports constipation, a radiograph could be used to confirm that diagnosis or to offer alternative diagnosis, such as bowel obstruction [26,27].

Variant 1: Palpable abdominal mass. Suspected intra-abdominal neoplasm. Initial imaging. E. Fluoroscopy Procedures (Contrast Enema, Upper GI Series, Small-Bowel Follow-Through)

Fluoroscopy studies, such as contrast enema, upper gastrointestinal (GI) series, and small-bowel follow-through (SBFT), are usually not first-line imaging studies for palpable masses in adults. However, they may be used to further characterize associated degree of obstruction or abnormalities in GI function or transit [28]. As extraluminal findings are commonly not evaluated by contrast enema or upper GI series, additional imaging may be required even if an intraluminal mass is detected.

Variant 1: Palpable abdominal mass. Suspected intra-abdominal neoplasm. Initial imaging. F. FDG-PET/CT Skull Base to Mid-Thigh

In the absence of a known diagnosis, there is a very limited role for fluorine-18-2-fluoro-2-deoxy-D-glucose (FDG)-PET/CT in patients with palpable abnormalities. There is no literature to support its use as an initial imaging modality. The main role of FDG-PET/CT would be to stage a known neoplasm, potentially presenting with a new palpable abnormality.

Variant 2: Palpable abdominal mass. Suspected abdominal wall mass. Initial imaging.

The annual incidence of benign soft-tissue masses is approximately 3,000 per million population [29]. The rate of malignancy ranges from 5% to 42% in large series [30,31]. Clinical evaluation and history are important for developing a differential diagnosis, with features of large size, location within the abdominal cavity, growth, and recurrence at an excision site in a patient with a history of malignancy all raising suspicion of malignancy [31]. Imaging often plays a central role in further narrowing the differential diagnosis and guiding management. However, similar to Variant 1, there are few recent studies, and the overall quality of the literature is poor and primarily focused on specific disease processes rather than a diagnostic approach to palpable masses [32-36].

The differential diagnosis related to the abdominal wall includes soft-tissue neoplasms of the skin, muscle, fat, bone, and vasculature. Additionally, hernias, congenital abnormalities, hematomas, and infections may present as abdominal wall masses. Differentiation of tissue components, such as blood products, fat, and vascularity, is important for narrowing the differential diagnosis and defining the relationship of the mass to tissue planes and structures is imperative in guiding management.

Variant 2: Palpable abdominal mass. Suspected abdominal wall mass. Initial imaging. A. US Abdomen

Although no recent studies have evaluated the diagnostic accuracy of US specifically for abdominal wall masses, it is typically considered a first-line imaging modality [29,30,32]. This is due to the many advantages of US, such as capability of real-time imaging, Doppler evaluation of blood flow, and ability to assess for clinical features, such as tenderness. US can sometimes depict classic features of benign lesions, such as lipomas, desmoid tumors, vascular malformations, rectus sheath hematomas, infections, pseudoaneurysms, and endometriosis [30,32-34,36-38]. However, in the setting of solid lesions, further workup and potentially tissue sampling is often needed. Although perhaps not widely used as a first-line imaging option, US can also confirm the presence of malignant masses, such as metastatic disease, sarcomas, and lymphomas. In a prospective study of 358 patients presenting with soft-tissue masses, US was performed as an initial imaging modality,

yielding effective triage results with 100% specificity in referring indeterminate or potentially malignant masses on to more definitive imaging (MRI) and subsequent workup [31].

In patients with suspected abdominal wall endometriosis, which presents as a mass in many instances, US correctly detected disease in approximately 97% of cases in a retrospective series of 151 patients evaluated surgically [36]. In a systematic review of the literature on abdominal wall endometriosis, the authors concluded that the overall quality of evidence is poor with no prospective studies; however, US or MRI can assist with localization and aid in surgical planning [39].

US has several limitations. It can be less specific than other imaging modalities for characterizing masses [31]. US visibility of the abdominal wall is usually possible with few limitations. However, US may not provide details of deeper structures and relationship of masses to anatomic fascial planes. US also has advantages; it has the benefit of real-time imaging, such as assessing dynamic changes like Valsalva maneuvers, when evaluating for hernias. US is considered highly useful for real-time guidance for biopsy, but percutaneous biopsy should be considered carefully and in conjunction with oncologic specialist when a sarcoma is suspected [30].

Variant 2: Palpable abdominal mass. Suspected abdominal wall mass. Initial imaging.
B. MRI Abdomen

There is little recent literature on the diagnostic accuracy of MRI for abdominal wall mass evaluation. MRI acquired without and with IV contrast is recognized as a useful modality to further narrow the differential diagnosis of detected masses, because of its high soft-tissue contrast resolution, ability to differentiate fat and enhancement within structures, and sequences that identify iron and blood products that may aid in differential considerations, such as endometriosis or extramedullary hematopoiesis [10,35]. MRI acquired without and with IV contrast can depict specific imaging features for many entities, including endometriosis, simple lipomas, epidermoid cysts, desmoid tumors, and hematomas [38]. MRI acquired without IV contrast may also still depict soft-tissue structures and define anatomy/pathology. MRI may be a useful second-line examination, often recommended if a malignant or indeterminate mass is detected on US [29,30]. In a series of 126 consecutive cases of fatty masses, MRI had a sensitivity of 100%, specificity of 83%, accuracy of 84%, and negative predictive value of 100% for differentiating simple lipoma from liposarcoma [40].

Although helpful in defining relationship of masses to adjacent fascia, muscles, and vessels, MRI is often not specific enough to establish a definitive diagnosis, and biopsy or excision is usually required following consultation or referral by oncologic specialists [29,38].

Variant 2: Palpable abdominal mass. Suspected abdominal wall mass. Initial imaging.
C. CT Abdomen

There is little recent literature on the accuracy and diagnostic yield of CT for abdominal wall masses; however, CT is widely considered fast and accurate for excluding or confirming a mass. Because of the relative lack of soft-tissue resolution compared with MRI, it may not be a first- or second-line option for evaluation of abdominal masses. CT may be additionally helpful in the setting of suspected hernia, congenital abnormalities, hematomas, and infections [41,42]. Additionally, there may be a role in the setting of endometriosis for differentiation from other masses [43]. When malignant masses are suspected, CT may provide benefit of staging information related to metastatic disease in addition to defining the size, location, and relationship of a mass to

adjacent structures.

There are no recent studies that specifically address the question of whether CT should be performed with or without IV contrast for a palpable mass. Acquisition of CT both with and without contrast does not generally add diagnostic value. Although available evidence and experience generally supports the appropriateness of CT with IV contrast over that of noncontrast CT for evaluation of intra-abdominal organs and pathology [12,14,15], the use of noncontrast CT may be of value in some circumstances.

CT may be of benefit in guiding biopsy and should be considered carefully and in conjunction with oncologic specialist when a sarcoma is suspected [30].

Variant 2: Palpable abdominal mass. Suspected abdominal wall mass. Initial imaging.
D. FDG-PET/CT Skull Base to Mid-Thigh

In the absence of a known diagnosis, there is a very limited role for FDG-PET/CT in patients with palpable abnormalities. There is no literature to support its use as an initial imaging modality. The main role of FDG-PET/CT would be to stage a known neoplasm, potentially presenting with a new palpable abnormality.

Variant 2: Palpable abdominal mass. Suspected abdominal wall mass. Initial imaging.
E. Radiography Abdomen

Radiography plays a very limited role in evaluation of abdominal wall masses. There may be a role if there is suspicion of an osseous lesion arising from the rib, vertebral bodies, or pelvic bones.

Variant 2: Palpable abdominal mass. Suspected abdominal wall mass. Initial imaging.
F. Fluoroscopy Procedures (Contrast Enema, Upper GI Series, Small-Bowel Follow-Through)

There is no literature to support the use of fluoroscopy for primary evaluation of suspected abdominal wall masses. Even if there is clinical suspicion for bowel herniation, US may be a better first-line imaging modality.

Summary of Recommendations

- **Variant 1**: CT abdomen with IV contrast or US of the abdomen are individually usually appropriate for the initial imaging of a palpable abdominal mass which is a suspected intra-abdominal neoplasm. 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 of the abdomen, CT abdomen with IV contrast, or MRI abdomen without and with IV contrast are each individually usually appropriate for the initial imaging of a palpable abdominal mass which is a suspected abdominal wall mass. 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, please go to the ACR website at https://www.acr.org/Clinical-Resources/Clinical-Tools-and-Reference/Appropriateness-Criteria.

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 [44].

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".		

References

1. Kransdorf MJ, Murphey MD, et al. ACR Appropriateness Criteria® Soft-Tissue Masses. J Am Coll Radiol. 2018 May;15(5S):S1546-1440(18)30337-5.
2. Reis SP, Majdalany BS, AbuRahma AF, et al. ACR Appropriateness Criteria® Pulsatile Abdominal Mass Suspected Abdominal Aortic Aneurysm. J Am Coll Radiol 2017;14:S258-S65.
3. American College of Radiology. ACR Appropriateness Criteria®: Clinically Suspected Adnexal Mass. Available at: https://acsearch.acr.org/docs/69466/Narrative/.
4. Makni A, Jouini M, Kacem M, Safta ZB. Extra-hepatic intra-abdominal hydatid cyst: which characteristic, compared to the hepatic location?. Updates Surg. 65(1):25-33, 2013 Mar.
5. Tarcoveanu E, Moldovanu R, Bradea C, Vlad N, Ciobanu D, Vasilescu A. Laparoscopic Treatment of Intraabdominal Cystic Lymphangioma. Chirurgia (Bucur). 111(3):236-41, 2016 May-Jun.
6. Zhou Z, Zhou J, Wu Z, Peng B. Laparoscopic splenectomy for adult lymphangiomas of the spleen: case series and review of literature. Hepatogastroenterology. 61(130):285-90, 2014 Mar-Apr.
7. Zhu QQ, Zhu WR, Wu JT, Chen WX, Wang SA. Comparative study of intestinal tuberculosis and primary small intestinal lymphoma. World J Gastroenterol. 20(15):4446-52, 2014 Apr 21.
8. Dixon AK, Fry IK, Kingham JG, McLean AM, White FE. Computed tomography in patients with an abdominal mass: effective and efficient? A controlled trial. Lancet. 1981;1(8231):1199-1201.
9. Williams MP, Scott IH, Dixon AK. Computed tomography in 101 patients with a palpable abdominal mass. Clin Radiol. 1984;35(4):293-296.
10. Roberts AS, Shetty AS, Mellnick VM, Pickhardt PJ, Bhalla S, Menias CO. Extramedullary haematopoiesis: radiological imaging features. [Review]. Clin Radiol. 71(9):807-14, 2016 Sep.
11. Lipnik AJ, Brown DB. Image-Guided Percutaneous Abdominal Mass Biopsy: Technical and Clinical Considerations. [Review]. Radiol Clin North Am. 53(5):1049-59, 2015 Sep.
12. Sainani NI, Arellano RS, Shyn PB, Gervais DA, Mueller PR, Silverman SG. The challenging image-guided abdominal mass biopsy: established and emerging techniques 'if you can see it, you can biopsy it'. [Review]. Abdom Imaging. 38(4):672-96, 2013 Aug.
13. Vanoeteren X, Devreese K, De Munter P. Abdominal actinomycosis: a rare complication after

cholecystectomy. Acta Clin Belg. 69(2):152-6, 2014 Apr.

14. Blake MA, Kalra MK, Sweeney AT, et al. Distinguishing benign from malignant adrenal masses: multi-detector row CT protocol with 10-minute delay. Radiology. 238(2):578-85, 2006 Feb.

15. Love L, Malone A, Churchill R, et al. Intravenous contrast bolus in computed tomography investigation of mass lesion. Diagn Imaging Clin Med. 53(2):57-66, 1984.

16. Aspelin P, Hildell J, Karlsson S, Sigurjonson S. Ultrasonic evaluation of palpable abdominal masses. Acta Chir Scand. 1980;146(7):501-506.

17. Barker CS, Lindsell DR. Ultrasound of the palpable abdominal mass. Clin Radiol. 1990;41(2):98-99.

18. Colquhoun IR, Saywell WR, Dewbury KC. An analysis of referrals for primary diagnostic abdominal ultrasound to a general X-ray department. British Journal of Radiology. 61(724):297-300, 1988 Apr.

19. Holm HH, Gammelgaard J, Jensen F, Smith EH, Hillman BJ. Ultrasound in the diagnosis of a palpable abdominal mass. A prospective study of 107 patients. Gastrointest Radiol. 1982;7(2):149-151.

20. Annuar Z, Sakijan AS, Annuar N, Kooi GH. Ultrasound in the diagnosis of palpable abdominal masses in children. Med J Malaysia. 1990;45(4):281-287.

21. White M, Stella J. Ovarian torsion: 10-year perspective. Emerg Med Australas. 2005;17(3):231-237.

22. Arishenkoff S, Eddy C, Roberts JM, et al. Accuracy of Spleen Measurement by Medical Residents Using Hand-Carried Ultrasound. Journal of Ultrasound in Medicine. 34(12):2203-7, 2015 Dec.

23. Colli A, Prati D, Fraquelli M, et al. The use of a pocket-sized ultrasound device improves physical examination: results of an in- and outpatient cohort study. PLoS ONE [Electronic Resource]. 10(3):e0122181, 2015.

24. Atamanalp SS. Sigmoid volvulus: diagnosis in 938 patients over 45.5 years. Techniques in Coloproctology. 17(4):419-24, 2013 Aug.

25. Baleato-Gonzalez S, Vilanova JC, Garcia-Figueiras R, Juez IB, Martinez de Alegria A. Intussusception in adults: what radiologists should know. Emerg Radiol. 2012;19(2):89-101.

26. Chang CJ, Hsieh TH, Tsai KC, Fan CM. Sigmoid volvulus in a young woman nearly misdiagnosed as fecal impaction. J Emerg Med. 2013;44(3):611-613.

27. Osiro SB, Cunningham D, Shoja MM, Tubbs RS, Gielecki J, Loukas M. The twisted colon: a review of sigmoid volvulus. Am Surg. 2012;78(3):271-279.

28. Patel DR, Levine MS, Rubesin SE, Zafar H, Lev-Toaff AS. Comparison of small bowel follow through and abdominal CT for detecting recurrent Crohn's disease in neoterminal ileum. Eur J Radiol. 82(3):464-71, 2013 Mar.

29. Williams KJ, Hayes AJ. A guide to oncological management of soft tissue tumours of the abdominal wall. [Review]. Hernia. 18(1):91-7, 2014 Feb.

30. Bashir U, Moskovic E, Strauss D, et al. Soft-tissue masses in the abdominal wall. [Review]. Clin Radiol. 69(10):e422-31, 2014 Oct.

31. Lakkaraju A, Sinha R, Garikipati R, Edward S, Robinson P. Ultrasound for initial evaluation and triage of clinically suspicious soft-tissue masses. Clin Radiol. 64(6):615-21, 2009 Jun.

32. Ahn SE, Park SJ, Moon SK, Lee DH, Lim JW. Sonography of Abdominal Wall Masses and Masslike Lesions: Correlation With Computed Tomography and Magnetic Resonance Imaging. J Ultrasound Med. 35(1):189-208, 2016 Jan.

33. Mostafa HA, Saad JH, Nadeem Z, Alharbi F. Rectus abdominis endometriosis. A descriptive analysis of 10 cases concerning this rare occurrence. Saudi Med J. 34(10):1035-42, 2013 Oct.

34. Smithson A, Ruiz J, Perello R, Valverde M, Ramos J, Garzo L. Diagnostic and management of spontaneous rectus sheath hematoma. EUR. J. INTERN. MED.. 24(6):579-82, 2013 Sep.

35. Solak A, Sahin N, Genc B, Sever AR, Genc M, Sivrikoz ON. Diagnostic value of susceptibility-weighted imaging of abdominal wall endometriomas during the cyclic menstrual changes: a preliminary study. Eur J Radiol. 82(9):e411-6, 2013 Sep.

36. Zhang J, Liu X. Clinicopathological features of endometriosis in abdominal wall--clinical analysis of 151 cases. Clin Exp Obstet Gynecol. 43(3):379-83, 2016.

37. Otero S, Moskovic EC, Strauss DC, et al. Desmoid-type fibromatosis. [Review]. Clin Radiol. 70(9):1038-45, 2015 Sep.

38. Virmani V, Sethi V, Fasih N, Ryan J, Kielar A. The abdominal wall lumps and bumps: cross-sectional imaging spectrum. [Review]. Can Assoc Radiol J. 65(1):9-18, 2014 Feb.

39. Rindos NB, Mansuria S. Diagnosis and Management of Abdominal Wall Endometriosis: A Systematic Review and Clinical Recommendations. [Review]. Obstet Gynecol Surv. 72(2):116-122, 2017 Feb.

40. Gaskin CM, Helms CA. Lipomas, lipoma variants, and well-differentiated liposarcomas (atypical lipomas): results of MRI evaluations of 126 consecutive fatty masses. AJR Am J Roentgenol. 182(3):733-9, 2004 Mar.

41. 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 Am J Roentgenol 2005;184:847-51.

42. Gayer G, Park C. Abdominal Wall Masses: CT Findings and Clues to Differential Diagnosis. [Review]. Semin Ultrasound CT MR. 39(2):230-246, 2018 Apr.

43. Yarmish G, Sala E, Goldman DA, et al. Abdominal wall endometriosis: differentiation from other masses using CT features. Abdom Radiol. 42(5):1517-1523, 2017 05.

44. American College of Radiology. ACR Appropriateness Criteria® Radiation Dose Assessment Introduction. Available at: https://edge.sitecorecloud.io/americancoldf5f-acrorgf92a-productioncb02-3650/media/ACR/Files/Clinical/Appropriateness-Criteria/ACR-Appropriateness-Criteria-Radiation-Dose-Assessment-Introduction.pdf.

Disclaimer

Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the FDA have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.

[a]Mallinckrodt Institute of Radiology, Saint Louis, Missouri. [b]Virginia Tech Carilion School of Medicine, Roanoke, Virginia. [c]Panel Chair, University of Wisconsin Hospital & Clinics, Madison, Wisconsin. [d]University of Texas Health Science Center at Houston and McGovern Medical School, Houston, Texas; American Gastroenterological Association. [e]Newton-Wellesley Hospital, Newton, Massachusetts. [f]The University of Texas MD Anderson Cancer Center, Houston, Texas; American College of Surgeons. [g]H. Lee Moffitt Cancer Center and Research Institute, Tampa, Florida; Commission on Nuclear Medicine and Molecular Imaging. [h]Massachusetts General Hospital, Boston, Massachusetts. [i]Medstar Georgetown University Hospital, Washington, District of Columbia. [j]Cleveland Clinic, Cleveland, Ohio. [k]Duke University Medical Center, Durham, North Carolina. [l]Emory University, Atlanta, Georgia. [m]Penn State Health, Hershey, Pennsylvania. [n]University of Alabama at Birmingham, Birmingham, Alabama. [o]Beth Israel Deaconess Medical Center, Boston, Massachusetts. [p]Specialty Chair, Virginia Commonwealth University Medical Center, Richmond, Virginia.