American College of Radiology
ACR Appropriateness Criteria®
Acute Onset of Scrotal Pain-Without Trauma, Without Antecedent Mass

Variant 1: **Adult or child. Acute onset of scrotal pain. Without trauma, without antecedent mass. Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
US duplex Doppler scrotum	Usually Appropriate	O
US scrotum	Usually Appropriate	O
MRI pelvis (scrotum) without and with IV contrast	Usually Not Appropriate	O
MRI pelvis (scrotum) without IV contrast	Usually Not Appropriate	O
CT pelvis with IV contrast	Usually Not Appropriate	☢☢☢
CT pelvis without IV contrast	Usually Not Appropriate	☢☢☢
Nuclear medicine scan scrotum	Usually Not Appropriate	☢☢☢
CT pelvis without and with IV contrast	Usually Not Appropriate	☢☢☢☢

ACUTE ONSET OF SCROTAL PAIN-WITHOUT TRAUMA, WITHOUT ANTECEDENT MASS

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<u>Summary of Literature Review</u>

Introduction/Background

The acute scrotum is a medical emergency defined as scrotal pain, swelling and redness of acute onset, from minutes to 1 to 2 days [1] and comprises at least 0.5% of all emergency department visits [2]. Etiologies of acute scrotum are numerous, and rapid accurate diagnosis is essential to appropriately triage potentially surgical and irreversible conditions from patients for whom conservative management is sufficient. Diagnostic considerations include testicular torsion, torsion of testicular appendage, epididymoorchitis, epididymitis, idiopathic scrotal edema, hydrocele, inflammation of the tunica vaginalis, trauma, testicular tumors, epididymal cysts, Fournier gangrene, scrotal abscess, and strangulated inguinal hernia [3-6]. Torsion of a testicular appendage, epididymitis, and testicular torsion are the three most common causes of acute scrotal pain and account for approximately 85% to 90% of cases [7]. Large differential diagnoses and overlapping clinical presentation make the acute scrotum a diagnostic challenge.

Acute epididymoorchitis or epididymitis is the most common cause of acute scrotum in adolescent boys and adults [8,9]. In 2002, epididymitis or epididymoorchitis accounted for 1 in 44 outpatient visits in men 18 to 50 years of age [9,10]. Although uncommon in pediatric populations, it can be associated with urinary tract infections and/or structural and functional abnormalities of the urinary tract [11,12]. Epididymitis has a more insidious and gradual onset than testicular torsion. As inflammation and edema progress, a reactive hydrocele may develop making it difficult to differentiate from testicular torsion. Clinically, scrotal pain associated with epididymitis is usually relieved when the testes are elevated over the symphysis pubis (the Prehn sign) [8,13]. This sign may help clinically differentiate between epididymitis and torsion of the spermatic cord, in which scrotal pain is not lessened with this maneuver [14].

Torsion of the testicular appendage is the most common etiology in prepubertal boys [5,12,15,16]. Clinical presentations such as focal tenderness over the upper pole of the testes and sudden onset of symptoms can overlap with the presentations of epididymitis and testicular torsion [12,16]. Infarction and necrosis of the appendage can be seen as a “blue dot sign,” which is visualization of the infarcted appendage through the skin appearing as a blue dot. Albeit pathognomonic for appendage torsion [3,16], it is only seen in 21% of cases [17]. Scrotal edema develops rapidly, obscuring this finding on physical examination [18].

Testicular torsion is defined as twisting of the spermatic cord, compromising blood flow to and from the testes [2]. It is a surgical emergency with a bimodal distribution presenting more frequently in neonates and postpubertal boys than in adults, although it can occur at any age [19]. It has an estimated reported yearly incidence ranging from 2.9 to 3.8 in 100,000 boys <18 years of age [20,21]. Prompt recognition and surgical exploration within 6 to 8 hours after symptom onset is essential to prevent testicular loss [22]. A validated [23-26], clinical risk scoring system, Testicular Workup for Ischemia and Suspected Torsion Score, has shown high positive predictive value; however, it has not been widely adopted [20].

Special Imaging Considerations

Contrast-enhanced ultrasound (US) has expanded considerably in the last few decades and has proved to be a useful tool in determining the presence or absence of organ perfusion by improving the signal-to-noise ratio of tissue

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[27,28]. In principle it is able to detect and display echoes from individual bubbles, and therefore it is able to assess microvascularity, with an adverse event rate lower than or similar to that reported for other contrast agents [29-31]. On this basis, contrast-enhanced US can be considered as a possible problem-solving technique for diagnosing testicular torsion in children's small testicles in whom conventional Doppler methods fail to identify flow also in the contralateral side [32].

Microvascular imaging US is a new Doppler module that better differentiates slow flow via mathematical algorithms based on signal amplitude width [33], by separating low frequency of static tissue artifacts from low frequencies of very weak flow. Microvascular imaging obtains a higher resolution by separating the Doppler components of the 2 different sources [34].

Shear wave elastography (SWE) is a recently developed technique capable of quantitatively evaluating soft tissue stiffness [35,36]. This serves as a surrogate marker for tissue composition. Studies have shown that SWE values of testicular parenchyma increase during testicular torsion; however, there are limited studies showing whether these changes can be distinguished from other pathologies such as acute inflammation [36].

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 where each procedure provides unique clinical information to effectively manage the patient's care).

Discussion of Procedures by Variant

Variant 1: Adult or child. Acute onset of scrotal pain. Without trauma, without antecedent mass. Initial imaging.

This discussion will be limited to patients with acute pain, without history of trauma, and no history of antecedent or known scrotal or testicular mass because these scenarios are discussed elsewhere [37,38].

CT Pelvis With IV Contrast

CT of the pelvis with intravenous (IV) contrast is not routinely used as an initial imaging modality for the evaluation of acute scrotal pain without trauma and without antecedent mass. There is no relevant literature regarding the use of CT of the pelvis in these patients. However, in the setting of Fourniers gangrene, CT can lead to early diagnosis with accurate assessment of disease extent [3].

CT Pelvis Without and With IV Contrast

CT of the pelvis without and with IV contrast is not routinely used as an initial imaging modality for the evaluation of acute scrotal pain without trauma and without antecedent mass. There is no relevant literature regarding the use of CT of the pelvis in these patients.

CT Pelvis Without IV Contrast

CT of the pelvis without IV contrast is not routinely used as an initial imaging modality for the evaluation of acute scrotal pain without trauma and without antecedent mass. There is no relevant literature regarding the use of CT of the pelvis in these patients.

MRI Pelvis (Scrotum) Without and With IV Contrast

MRI of the pelvis without and with IV contrast is not routinely used as an initial imaging modality for the evaluation of acute scrotal pain without trauma and without antecedent mass. However, it may be used as a problem solving second-line modality when findings on US are indeterminate [39,40]. Diagnoses such as minor tunica albuginea tears and blunt scrotal trauma, chronic epididymoorchitis, and partial or intermittent torsion may sometimes be missed on US [39,41,42]. Due to its larger field of view and multiplanar capabilities, MRI of the scrotum provides excellent anatomical detail of all scrotal contents and inguinal region. In addition, MRI provides high soft-tissue contrast, high sensitivity for contrast enhancement, and functional information. These features contribute to a more precise treatment strategy, reducing unwarranted surgical exploration [39,40,43-47]. Limitations of MRI in the evaluation of acute scrotum include long scan time, potentially delaying surgical exploration, and possible need for anesthesia in pediatric patients [39,40,48] and patients with claustrophobia or anxiety.

MRI has high accuracy in establishing the diagnosis of segmental testicular infarction [39,49-51]. Segmental testicular infarction is an uncommon entity that can mimic a small hypovascular tumor on US [50,52-55]. MRI findings include a T2 hypointense, avascular lesion with marked rim enhancement. Intralesional hyperintense T1 signal may coexist due to hemorrhagic products [39,44,50,55-57].

Dynamic contrast-enhanced MRI with subtraction imaging is highly sensitive and specific for the diagnosis of testicular torsion by characterizing testicular perfusion. According to a retrospective study of 39 patients (1–28 years of age) with acute scrotum, lack of contrast enhancement showed 100% specificity and 93% sensitivity for testicular torsion [58]. Other findings include spotty and/or streaky pattern of low or very low signal intensity on T2- and T2*-weighted images with 75% sensitivity for testicular torsion and 100% accuracy for testicular necrosis [59].

Diffusion-weighted imaging and apparent diffusion coefficient (ADC) provide qualitative and quantitative analysis by adding functional information about molecular activity and cellular function, in addition to the morphological information provided by other MRI sequences, like dynamic contrast-enhanced and T2- and T2*-weighted images [60,61]. Diffusion-weighted imaging and ADC images demonstrate lower ADC values of the torsed testicle compared to the normal contralateral testicle [62].

MRI has also been reported useful in the diagnosis of bell clapper deformity, an important risk factor for testicular torsion. MRI findings include hyperintense T2 signal between the posterior aspect of the epididymis and the scrotal wall, described as a “split sign,” correlating with bell clapper deformity, with 83% sensitivity in a recent retrospective study [63].

Patients with acute scrotal infections and inflammation could benefit from further characterization of extent of disease and complications such as skin involvement and fistula formation, aiding in surgical planning or percutaneous drainage [37,39,64,65]. MRI’s superior soft-tissue contrast resolution and larger field of view may be useful in patients with scrotal abscess, which may be difficult to differentiate from other entities such as testicular torsion, hematoma, or tumor on US [39,43,46,47,54,66,67]. MRI findings of scrotal abscess include T2 hyperintense fluid collection with variable T1 signal intensity and peripheral enhancement as well as testicular parenchymal enhancement and restricted diffusion on diffusion-weighted imaging with corresponding low signal on ADC map [44,64,65].

MRI Pelvis (Scrotum) Without IV Contrast

MRI of the pelvis without IV contrast is not routinely used as an initial imaging modality for the evaluation of acute scrotal pain without trauma and without antecedent mass. There is no relevant literature regarding the use of MRI of the pelvis without IV contrast in these patients.

Nuclear Medicine Scan Scrotum

Radionuclide scrotal imaging (RNSI) has been replaced by Doppler US as the primary imaging modality for evaluation of the acute scrotum. RSNI has a reported sensitivity and specificity for differentiation between testicular torsion and epididymoorchitis from 89% to 98% and 90% to 100%, respectively [68,69]. RSNI is limited by technical challenges in children whose small genitalia are difficult to image with radiotracers. RNSI also can have photon-deficient areas secondary to hydrocele, spermatocele, and inguinal hernias, which can be erroneously diagnosed as avascular testis [70].

US Duplex Doppler Scrotum

Spectral analysis of the Doppler waveform allows a quantitative assessment of organ perfusion.

Arterial and venous flow are absent when there is complete testicular torsion of >450°, making a sonographic diagnosis straightforward [71]. However, with partial or incomplete torsion, arterial flow is not necessarily absent because venous obstruction precedes arterial occlusion due to their thinner walls and lower pressure. The early manifestation of testicular torsion can be a diminished arterial velocity and a decreased diastolic flow with a consequently increased resistive index, indicating severe obstruction or occlusion of the venous outflow. Later, the diastolic flow can be absent or reversed [42,72]. Absent or reversed diastolic arterial flow can also be present with severe epididymitis or epididymoorchitis, with secondary venous outflow obstruction and subsequent venous infarction [73]. In a case series, partial testicular torsion was diagnosed after examination of the morphologic characteristics and amplitude of the spectral Doppler arterial waveform and its appearance relative to the contralateral testicle or a different region within the same testicle. Variability of the amplitude was the most common abnormality, followed by reversal of diastolic flow [6]. Additional characteristic spectral Doppler waveforms seen in partial testicular torsion include monophasic waveform, tardus-parvus morphology, and spectral Doppler waveform variations within the same testis, all worrisome for underlying ischemia. Spectral Doppler analysis should be performed in the upper, mid, and lower poles of each testicle [6,72,74].

US Scrotum

US is the established first-line imaging modality for acute scrotal disease [75] and can be used to diagnose most scrotal disorders when combined with clinical history and physical examination. US is generally well tolerated and widely available, making it ideal for scrotal evaluation. High-resolution grayscale and color Doppler US allow prompt and accurate differentiation of scrotal emergencies [49,54,76,77].

Testicular perfusion can be evaluated with color Doppler, power Doppler, and spectral Doppler US [76]. Power Doppler is valuable in scrotal US because of its increased sensitivity to low-flow states and its independence from Doppler angle correction [76,78].

In testicular torsion, venous obstruction occurs first, followed by obstruction of arterial flow and ultimately by testicular ischemia. The extent of testicular ischemia depends on the degree of torsion, which ranges from 180° to 720° or greater. The testicular salvage rate depends on the degree of torsion and the duration of ischemia [79]. Furthermore, torsion may be complete, incomplete, or transient. US findings include an enlarged heterogeneous testis that may be hypoechoic, ipsilateral hydrocele, skin thickening, and no color Doppler flow in the testis or spermatic cord [76]. However, in the first few hours of symptom onset it can also appear within normal limits [54,77]. The sensitivity and specificity of color Doppler US for the detection of testicular torsion is variable, with reports ranging from 69% to 96.8% and 87% to 100%, respectively [80-83]. False-negative Doppler evaluations (with sustained perfusion) can occur in the setting of partial torsion and spontaneous detorsion [77,82,84-87]. False-positive Doppler evaluation can be seen in infants and young boys who often have normally reduced intratesticular blood flow [71,77,88]. The contralateral asymptomatic testicle should be used as an internal control.

A twisted spermatic cord is the most specific US sign of torsion [89]. The "whirlpool sign" refers to a spiral twist of the spermatic cord that may be associated with a heterogeneously echogenic pseudomass below the point of torsion, seen on grayscale imaging. This pseudomass corresponds to a congested epididymis, vas deferens, and distal cord vessels [85,87,89,90].

US findings in patients with epididymitis include an enlarged and hypoechoic epididymis due to edema. Reactive hydroceles and scrotal wall thickening can also be seen. Color Doppler imaging shows increased blood flow corresponding to hyperemia, which is an important diagnostic feature of epididymitis. The sensitivity of color Doppler in detecting scrotal inflammation is nearly 100% [76,91]. The epididymis is the organ primarily involved in epididymoorchitis, with orchitis developing in 20% to 40% due to direct retrograde spread of infection [76]. Reperfusion after early ischemia, seen with torsion/detorsion, can induce a reactive hyperemia on color Doppler imaging, which is not sonographically distinguishable from the hyperemia seen with acute epididymoorchitis. Correlation with clinical data including presence of fever, waxing, and waning pain, as well as laboratory markers for infection must be integrated in the clinical assessment to distinguish both entities [54].

Summary of Recommendations

- **Variant 1**: US duplex Doppler scrotum and US scrotum is usually appropriate as the initial imaging for the acute onset of scrotal pain without trauma or antecedent mass in an adult or child. 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 [92].

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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