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
MRI pelvis (scrotum) without and with IV contrast	May Be Appropriate	O
Nuclear medicine scan scrotum	Usually Not Appropriate	☢☢☢
MRI pelvis (scrotum) without IV contrast	Usually Not Appropriate	O

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

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Summary of Literature Review

Introduction/Background

An acute scrotum is defined as testicular swelling with acute pain and can reflect multiple etiologies, including epididymitis or epididymo-orchitis, torsion of the spermatic cord, or torsion of the testicular appendages. Quick and accurate diagnosis of acute scrotum and its etiology is necessary because a delayed diagnosis of torsion for as little as 6 hours can cause irreparable testicular damage [1,2].

The single most common cause for acute scrotal pain is epididymitis. There are approximately 600,000 cases of epididymitis diagnosed every year in the United States [3]. Infection is commonly seen in patients 19 to 25 years of age, and overwhelmingly is the etiology for acute scrotum in patients >25 years of age [3]. Torsion is rare in patients >35 years of age [4].

Acute scrotum in prepubertal boys occurs most commonly from torsion of the testicular appendages, a process that can mimic testicular torsion or epididymo-orchitis [2,4]. The pathognomonic physical examination finding of the "blue dot sign" is infrequently encountered [1]. Perinatal testicular torsion is not uncommon, accounting for 10% of cases in children [5].

Testicular torsion typically presents as abrupt scrotal pain, whereas epididymitis has a more gradual pain onset. Patients with torsion can have normal urinalysis; however, this does not exclude epididymitis [6]. There is overlap in the clinical presentation of different causes of acute scrotal pain. For the pediatric patient (3 months–18 years of age), a clinically validated scoring system—Testicular Workup for Ischemia and Suspected Torsion (TWIST)—has been shown to have high positive predictive values. Patients with high TWIST scores should go on to urological evaluation rather than imaging; although, studies suggest that low and intermediate risk groups will benefit from Doppler ultrasound (US) [7,8]. In equivocal cases, imaging can augment the clinical examination findings and either diagnose testicular torsion early enough to salvage the testicle or identify other etiologies to prevent unnecessary operations [9,10].

A study comparing primary scrotal exploration (294 patients) and initial US examination (332 patients) with exploration for positive US results or a high clinical suspicion of torsion [11] showed that US obviated the need for exploration in many patients and thus shortened hospital stays. A more recent study in 258 young men who were between 3 months and 18 years in age compared the TWIST scores and initial US demonstrated receiver operator characteristics curves for TWIST with an area under the curve of 0.82 versus 0.89 for US, and the results suggested a Doppler US should still be performed even in low-risk patients to avoid missing intermittent torsion or torsion that has atypical findings [8].

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Discussion of Procedures by Variant

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

This criterion will be limited to patients with acute pain, without history of trauma, and no history of antecedent scrotal or testicular mass since these scenarios may affect management plans.

US Duplex Doppler Scrotum

Standard US of the scrotum includes both grayscale and Doppler examination of the bilateral scrotal and inguinal areas. Although grayscale is less sensitive for torsion, it can help identify other diagnoses, such as inflammation that is due to epididymitis or solid/cystic scrotal masses. Additionally, a normal homogenous echo pattern is less likely to represent a nonviable testis than an inhomogenous testis on grayscale imaging [12]. Real-time grayscale imaging is most helpful to identify a spermatic cord "twist" as seen in 199 of 208 patients (sensitivity 96%), whereas a normal linear cord was found in patients without torsion (705 of 711 patients, 99% specificity) [13,14]. This twisted cord finding is known as the "whirlpool sign" and can be seen above the testis, external to the inguinal ring [14,15]. A cine clip in transverse plane moving along the course of the spermatic cord can help identify the finding.

Testicular perfusion is best assessed by color Doppler US [12,16]. Duplex Doppler is another often employed tool that involves acquisition and display of color Doppler and spectral Doppler waveforms in conjunction with grayscale sonographic imaging. Power Doppler US can be used in place of, or as an adjunct to, color Doppler US. Power Doppler has been shown to be more sensitive than color Doppler, especially when evaluating areas of slow flow [12]. Power Doppler is especially useful to demonstrate intratesticular flow in prepubertal testes [17]. Reported sensitivity of color Doppler US in detecting torsion ranges from 96% to 100%, with a specificity of 84% to 95% [18]. In a series of 132 cases of acute scrotum, color Doppler US showed sensitivity of 91.7% and a specificity of 99.2% [19]. A negative US examination is highly predictive of the absence of torsion at the time of imaging [20]. In a prospective study of 104 boys presenting with acute scrotum, duplex Doppler US had sensitivity of 91% (95% confidence interval [CI]: 61.2%–99.5%), specificity of 87% (95% CI: 81.3%–89.0%), and accuracy of 90% (95% CI: 79.9%–92.4%) for diagnosis of testicular torsion [7]. In a retrospective analysis of Doppler US evaluation of 498 patients with acute scrotum, sensitivity of 75.8%, specificity of 98.9%, and diagnostic accuracy of 97.6% was determined for the evaluation of testicular torsion, and the authors found that Doppler US significantly increased the predictivity of the diagnostic process for acute scrotum [9].

Blood flow can be preserved in patients despite torsion, which is a potential pitfall of color Doppler [14,21,22]. Spectral Doppler waveform patterns (high-resistance arterial and monophasic waveforms) [22] and spermatic cord morphology (twisted or thickened spermatic cord) can help diminish false-negative results.

In adults and adolescent boys, epididymo-orchitis is the most common cause of acute scrotal pain. On US, the epididymis is enlarged, has increased flow on color Doppler, and can be increased or decreased in echogenicity. Scrotal wall thickening and hydrocele are common. Studies in patients with epididymitis report up to a 20% concomitant rate for orchitis [23]. Rarely, acute epididymo-orchitis can be complicated by global testicular infarction, which has been associated with a juxtaepididymal color Doppler signal with a "string-of-beads" appearance [24].

The most common cause of scrotal pain in children is torsion of the appendix testis [25]. Reactive changes (hydrocele, epididymal head enlargement, increased color Doppler flow) from torsion of a testicular appendage may mimic epididymitis [4]. A torsed testicular appendage can be difficult to see by US. A size criterion of >5.6 mm may discriminate a torsed testicular appendage but has low sensitivity (57%) and high specificity (100%), which sometimes obviates the need for surgery [26].

Scrotal fat necrosis is an uncommon but comparatively benign etiology of scrotal pain. Typically, the patient is a prepubescent boy with recent cold exposure, often from swimming. Bilateral intrascrotal masses caudal to the testes are palpated, and the testes appear normal on US, while the caudal scrotal fat is characteristically hyperechoic with posterior shadowing [27].

An uncommon cause of scrotal pain in adult men (median age 37–38 years) is segmental testicular infarction [28,29]. Classic imaging appearance is a wedge-shaped avascular focal area on US; however, other studies have shown round lesions and color Doppler flow in one series [28]. If US is equivocal, MRI can be helpful to identify

segmental testicular infarction [29]. Contrast-enhanced US is a technique that may be used to evaluate for infarction; although, as of 2018, US contrast is not yet FDA approved for scrotal imaging [30,31].

Acute idiopathic scrotal edema is rare and self-limiting, commonly observed in children, and is a diagnosis of exclusion. Acute idiopathic scrotal edema is usually painless and classically has marked thickening of the scrotal wall with heterogeneous striated and edematous appearance with increased vascularity on US [32,33]. Other findings include increased peritesticular blood flow, reactive hydrocele and enlargement, and increased vascularity of the inguinal lymph nodes [33]. The testes and epididymis are normal and do not show increased vascularity.

MRI Pelvis (Scrotum)

MRI techniques are not typically used for the evaluation of acute scrotum. However, there has been increased use of MRI in assessing scrotal disease [1,34,35]. A retrospective study of 39 patients with acute scrotum reports that MRI has a 93% sensitivity and 100% specificity for diagnosing testicular torsion [35].

The most sensitive finding in torsion is decreased or lack of perfusion on dynamic contrast-enhanced MRI [36]. Other characteristics include low or very low signal intensities with spotty or streaky patterns on fat-suppressed T2-weighted, heavily T2-weighted, or T2*-weighted images [36]. The use of a combination of dynamic contrast-enhanced T1-weighted MRI with T2-weighted and T2*-weighted sequences may help distinguish patients with torsion alone from those with torsion and hemorrhagic necrosis [36]. To aid diagnosis, diffusion restriction and apparent diffusion coefficient (ADC) may be useful to differentiate testicular torsion from other scrotal disorders with the twisted testes having statistically lower mean ADC values than nonaffected testes, and the affected to nonaffected ratio ADC value was also significantly lower [37]. However, MRI cannot rule out intermittent torsion [36].

Although uncommon, segmental testicular infarction can be seen on MRI-unenhanced T1-weighted images as subtle central high-signal intensity from a focal hemorrhage. On T2-weighted images, it is well marginated but has variable signal intensity. With gadolinium chelate contrast, the lesion is avascular but circumscribed by an enhancing rim [29]. However, use of noncyclic gadolinium chelate agents in patients with end-stage chronic kidney disease or acute kidney injury risks developing nephrogenic systemic fibrosis [37].

Nuclear Medicine Scan Scrotum

Radionuclide scrotal imaging (RNSI) is uncommonly used and has been essentially replaced by Doppler US as the primary imaging modality for evaluation of the acute scrotum. RSNI may be used for further characterization and has reported sensitivity and specificity ranges for differentiation between testicular torsion and epididymo-orchitis from 89% to 98% and 90% to 100%, respectively [17,38,39]. One series, published in 1998, reported RSNI as a useful problem-solving tool in cases where US is equivocal [40]. However, RSNI is limited by technical challenges in children who have small genitalia, which are difficult to image with radiotracers. RNSI also can have photon-deficient areas secondary to hydrocele and spermatocele, and rarely inguinal hernias, which can be erroneously diagnosed as avascular testis [41].

Summary of Recommendations

- **Variant 1:** US duplex Doppler of the 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.

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 [42].

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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The ACR Committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those examinations generally used for evaluation of the patient's condition are ranked. 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.