CONTINUING MEDICAL EDUCATION

The Acute Scrotum in Childhood and Adolescence

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SUMMARY

Background: The acute scrotum in childhood or adolescence is a medical emergency. Inadequate evaluation and delays in diagnosis and treatment can result in irreversible harm, up to and including loss of a testis. Various diseases can produce this clinical picture. The testis is ischemic in only about 20% of cases.

Methods: This review is based on a selective literature search, the existing clinical guideline, and the authors' experience.

Results: The clinical approach to the acute scrotum must begin with a standardized, rapidly performed diagnostic evaluation. Doppler ultrasonography currently plays a central role. Its main use is to demonstrate the central arterial blood supply and venous drainage of the testis. The resistance index of the testicular vessels should also be determined.

Conclusion: Physical examination and properly performed Doppler ultrasonography enable adequate evaluation of the acute scrotum in childhood and adolescence. In the rare cases of diagnostic uncertainty, immediate surgical exposure of the testis remains the treatment of choice.

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The acute scrotum in childhood or adolescence is a medical emergency (1, 2). The acute scrotum is defined as scrotal pain, swelling, and redness of acute onset (*Figure 1*). Because the testicular parenchyma cannot tolerate ischemia for more than a short time, testicular torsion must be ruled out rapidly as the cause (3, e1). Testicular torsion accounts for about 25% cases of acute scrotum, with an incidence of roughly 1 per 4000 young males per year. The goal of this CME article is to present a structured diagnostic and therapeutic approach to the acute scrotum, by means of which unnecessary operations and irreversible damage to the testicular parenchyma can be avoided.

Learning objectives

This article is intended to acquaint the reader with

- the standardized diagnostic evaluation,
- the necessary therapeutic measures, and
- the indications for surgery in cases of acute scrotum.

Methods

For this article, we selectively searched the PubMed database for articles containing the terms ["acute scrotum" OR "testicular torsion"] AND "children." We also refer to the current guidelines of the German Society for Pediatric Surgery (*Deutsche Gesellschaft für Kinderchirurgie*) and our own experience.

Diagnostic evaluation

The diagnostic evaluation begins with history-taking. The patient should be asked about the exact temporal course of events, the intensity of the pain, and, in particular, when the pain began (1, 2, 4). If the patient is a very small child, this information can only be obtained from a parent. The physician must also ask any new systemic symptoms or diseases already known to be

Definition

The acute scrotum is defined as scrotal pain, swelling, and redness of acute onset.

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Figure 1: Acute scrotum (left side) in an infant

BOX 1

History-taking in the acute scrotum

- Age
- Past medical history
- General symptoms
- First local symptom: pain before swelling?
- Pain: where? what kind? sudden onset?
- Trauma
- Prior surgery
- Nausea and vomiting
- Fever
- Dysuria
- Petechiae

present (*Box 1*) (1, 2, 4), particularly local problems, such as an inguinal hernia. B symptoms of hematologic disease and any newly arisen hematomata or petechiae should be asked about specifically. On physical examination (*Box 2*), the scrotum should be inspected, and a brief general physical examination should be performed (4). The involved testis should be palpated, and its position, size, and tenderness (if any) should be noted in comparison to the other side. The testis and epididymis should be evaluated separately, if possible. Next, the inguinal canal and the abdomen are palpated, and the cremasteric reflex is tested (4, 5, e2). The Ger and Prehn signs are no longer relevant in everyday practice (the former is retraction of the scrotal skin that may indicate testicular torsion in an early stage, and the latter is improvement of pain when the affected testicle is supported against gravity) (4, e2). The current German guidelines state that the Prehn sign remains useful to some extent, but this sign cannot be tested reliably in childhood.

In recent years, ultrasonography has emerged as the decisive radiological study for diseases of the scrotum, although there is no consensus on its reliability for the exclusion of testicular torsion (6–9, e3–e9). Some

authors consider it reliable for this purpose as long as the ultrasonographic technique meets certain specified criteria (6, 8), while others report, for example, cases of missed partial testicular torsion (e9). The physician who needs to know whether the testis may be damaged can accept no compromise on the reliability of diagnostic information. Two essential factors are the expertise of the physician performing the ultrasonographic study and the high quality of the apparatus used, which must have a 7–13 Mhz linear transducer with Doppler and power-Doppler functions (3, e3). Morphologically, an ultrasonographic study yields an estimate of testicular volume and an assessment of the echogenicity and any pathological features of the right and left testes in comparison to each other. For differential diagnosis, the study should include a search for an enlarged epididymis, a hydatid, a hematoma, or a tumor (3, e3, e4).

The ultrasonographic evaluation of testicular perfusion includes both the arterial and the venous flow signals (*Figure 2*) (3). The demonstration of central vessels in the testicular parenchyma is important, as perfusion may be preserved in the periphery and the outer coverings of the testis even in the presence of

History-taking

The patient should be asked about the exact temporal course of events, the intensity of the pain, and, in particular, when the pain began.

Physical examination

The scrotum should be inspected and a brief general physical examination should be performed. The involved testis should be palpated, and its position, size, and tenderness (if any) should be noted in comparison to the other side.

testicular torsion. In a personal case series including 61 cases of testicular torsion, the main author of this review found that all 61 were identifiable by the criterion of demonstrable central perfusion (6).

For accurate flow measurements in the testicular parenchyma, the wall filter and the pulse repetition frequency should be adapted to the flow velocity (1–5 cm/s). The wall filter permits a choice of especially low frequency ranges, so that low flow velocities can be measured. The pulse repetition frequency corresponds to the impulse-generator frequency and should be low for low flow velocities. The gain should be set optimally to keep artefacts to a minimum. The resistance index (RI) of the testicular vessels should be determined as well (3, 7, 10, 11, e10). An RI above 0.7 (mean: 0.43–0.75 [10]) with reversal of diastolic flow may indicate partial torsion (7, 10, e11). This cutoff value is appropriate from puberty onward (10, 12); for pre-pubertal children, RI values up to 1.0 are considered normal (mean: 0.39–1.0 [10]). Diastolic flow and the venous flow curve may be hard to demonstrate in infants and small children. The examiner can also try to demonstrate the testicular vessels in the area of the funiculus. Here, the finding of a spiral course is highly sensitive (96%) for testicular torsion (12, e12, e13). A comparison of the two sides is obligatory. Aside from the performance of the individual tests mentioned, it is medicolegally very important for the findings and their interpretation to be thoroughly documented in the medical record.

Theoretically, testicular perfusion could also be evaluated with magnetic resonance imaging or scintigraphy (e14–e18), but these tests are of little value for the diagnostic assessment of the acute scrotum in routine clinical practice because they are time-consuming, expensive, and hard to obtain.

There is no single laboratory test that can exclude testicular torsion. A reasonable laboratory profile to obtain in cases of suspected torsion consists of a complete blood count (with differential, if indicated) and serum C-reactive protein concentration. A urine sediment is needed to rule out urinary tract infection.

Etiology and differential diagnosis

The acute scrotum in childhood and adolescence has many potential causes. The differential diagnosis includes torsion, infection, trauma, tumor, and rarer causes (Table) (1–3, 7, e1, e5, e19).

Differential diagnosis

The differential diagnosis includes torsion, infection, trauma, tumor, and rarer causes.

BOX 2

Physical examination of the acute scrotum

- Position and orientation of the testes
(Brunzel sign = secondary high position of a testis)
- Size of the testes
- Cremasteric reflexes
- Site of maximal tenderness
- Color of the scrotum
- "Blue dot sign"
- Inguinal and abdominal examination

Torsion

Testicular torsion is a suddenly occurring rotation of a testis about its axis, resulting in twisting of the spermatic cord (Figure 3). The venous drainage of the testis is choked off and arterial perfusion is reduced, resulting in hemorrhagic infarction of the parenchyma. Subsequently, perfusion of the testis is totally lost. Complete testicular torsion, by definition, involves a full 360° rotation. Irreversible damage of the testicular parenchyma can be seen after four hours of ischemia (13). Studies have shown that only 50% of children who have had testicular ischemia for four hours or more go on to have normal spermogram findings in adulthood (13). The cause of testicular torsion is thought to be an abnormal degree of mobility of the suspension of the entire testis, or of the testis within its coverings, so that the testis can rotate about its own axis during physical exercise, trauma, or a suddenly occurring cremasteric reflex. Anatomical variants such as the bell-clapper anomaly, in which the gubernaculum, testis, and epididymis are not anchored as they normally are, predispose to testicular torsion (14, e20). Supravaginal torsion (i.e., torsion occurring above the tunica vaginalis) is more common in infants, while intravaginal torsion of the spermatic cord is the usual variant occurring in adolescence and is much more common overall (4).

Torsion

Testicular torsion is a suddenly occurring rotation of a testis about its axis, resulting in twisting of the spermatic cord.

Figure 2: Doppler ultrasonographic demonstration of testicular parenchymal perfusion with flow-curve registration in the triplex mode.

a) central arterial and b) venous perfusion (with the kind permission of PD Dr. J. P. Schenk, pediatric radiology, Dept. of Diagnostic and Interventional Radiology, Heidelberg).

The pain is acute and severe and may be accompanied by vomiting; shock-like symptoms are rare (1). The involved testis is often fixed in position near the body, or else it may lie obliquely instead of vertically, because of shortening of the twisted spermatic cord (4, e21). Absence of the cremasteric reflex is a sign of testicular torsion (5, e2).

The morphological appearance of the testis on ultrasonography depends on the duration of parenchymal ischemia. In the initial phase, there is usually a progressive increase in volume and a rather diffuse hypoechogenicity (3, 15, e3–e5, e7, e22). Later on, inhomogeneities arise that are taken to represent irreversible parenchymal damage (15, 16). There is a lack of consensus in the literature about the reliability of Doppler ultrasonography for assessing testicular parenchymal perfusion (6–9, 17, e5–e9, e23). Overall, its sensitivity and specificity are generally estimated at 89% to 100%, though different publications on this question use different ultrasonographic criteria for establishing the diagnosis, so that the comparability of findings across studies is limited (6, 18, e9). The decisive criterion for adequate testicular perfusion is the unambiguous

demonstration of central arterial and venous flow (1, 3). The demonstration of an arterial flow signal alone cannot exclude partial torsion. Spectral analysis (triplex mode) should be performed, and the RI should be determined (10, e11). The finding that the vessels of the spermatic cord are twisted into a spiral can be helpful in the differential diagnosis (13, e12, e13). A comparison with the other testis is obligatory in every case. In complete testicular torsion, no central perfusion can be seen.

Whenever Doppler ultrasonography arouses suspicion of testicular torsion, emergency surgical exploration of the testis is indicated (1, 2). The surgical approach can be either inguinal or scrotal. Infants nearly always have supravaginal torsion and should thus be operated on by an inguinal approach.

After detorsion of the vessels, the degree of ischemic damage of the testicular parenchyma should be assessed. Primary orchiectomy should be performed only if the testis is clearly necrotic (1); in all other cases, the testis should be anchored to the scrotum with two sutures. Having been left in place, the testis can later be reassessed ultrasonographically for reperfusion and potential secondary

Testicular torsion: history

The pain is acute and severe and may be accompanied by vomiting; shock-like symptoms are rare. The involved testis is often fixed in position near the body, or else it may lie obliquely instead of vertically.

Testicular torsion: Doppler ultrasonography

Whenever Doppler ultrasonography yields a suspected diagnosis of testicular torsion, emergency surgical exploration of the testis is indicated.

TABLE

The differential diagnosis of the acute scrotum in childhood and adolescence

Torsion	Infection	Trauma	Systemic disease	Other causes
<ul style="list-style-type: none"> – hydatid torsion – testicular torsion 	<ul style="list-style-type: none"> – epididymitis – orchitis 	<ul style="list-style-type: none"> – hematoma – hematocele – testicular rupture 	<ul style="list-style-type: none"> – Henoch–Schönlein purpura – lymphoma/leukemia 	<ul style="list-style-type: none"> – incarcerated inguinal hernia – scrotal edema – scrotal emphysema – appendicitis – testicular tumor

Figure 3: Intravaginal testicular torsion

a) Intraoperative findings in intravaginal testicular torsion in a 15-year-old boy

b) Histological section of the removed testicle with hemorrhagic necrosis and extensive erythrocyte extravasation in the interstitial tissue.

There are also degenerating testicular canals with centripetal maturation of spermiogenesis

parenchymal changes (6). Contralateral orchiopexy is obligatory as well, because the second testis is also at elevated risk of torsion (1).

Intermittent testicular torsion is a special case in which the initially severe acute pain rapidly improves (e24). Doppler ultrasonography reveals a hyperperfused testis. The differential diagnosis must include orchitis, although the pain of orchitis is normally continuous. Perfusion must be reassessed with Doppler ultrasonography at close intervals (every six hours at first), so that further episodes of torsion will not be missed (3).

Neonatal testicular torsion is another special case (15, 19, e25–e29). The torsion event often occurs

before birth, making the diagnosis difficult (15). The percentage of severe testicular damage is 100%, according to some studies (e27, e29), although there have been reports of testicular preservation by direct surgical intervention (15, 20, e25, e28). Accordingly, there are strongly conflicting opinions about the urgency of intervention in neonatal testicular torsion (e25, e27, e30, e31), ranging from the view that this is an acute emergency demanding immediate testicular exploration all the way to diagnostic and therapeutic nihilism (e25, e27, e30). Ultrasonography can yield additional information about the current extent of parenchymal damage (15). The principal author has reported elsewhere that recovery can be expected

Intermittent testicular torsion, a special case

In this entity, the initially severe acute pain rapidly improves. Doppler ultrasonography reveals a hyperperfused testis.

Neonatal testicular torsion

The torsion event often occurs before birth, making the diagnosis difficult. The percentage of severe testicular damage is 100%, according to some studies.

Figure 4: Hydatid torsion. Ultrasonographic demonstration of a round, hyperechogenic, non-perfused structure (marked) next to the upper pole of the testicle: hydatid in torsion (with the kind permission of PD Dr. J. P. Schenk, pediatric radiology, Dept. of Diagnostic and Interventional Radiology, Heidelberg)

if the testicular parenchyma is homogeneous (15). Doppler ultrasonography of the testis can be difficult to perform in a neonate. Whenever perfusion cannot be demonstrated with certainty, immediate exploration of the testis must follow (15, e31). Marked inhomogeneity or atrophy of the parenchyma on ultrasonography may be an exceptional reason to consider delayed testicular exploration (15).

Pathophysiologically, the processes of ischemia and reperfusion lead to a cascade of reactions in which neutrophilic leukocytes are activated and inflammatory cytokines (TNF- α and IL-1 β , among others) and adhesion molecules are released. N-acetylcysteine (NAC) has been found to have a protective effect on testicular tissue in animal models; thus, in the future, there may well be a form of drug therapy that will be given to patients with testicular torsion in addition to surgery (21, 22).

Hydatid torsion

In hydatid torsion, small appendages of the testis and epididymis undergo torsion and become ischemic.

These appendages are embryologic remnants of the Müllerian and Wolffian ducts (appendix testicularis and appendix epididymidis) (23). The clinical manifestations resemble those of testicular torsion. An important point for differential diagnosis is that the point of maximal tenderness is often directly above the testis; in some cases, resistance can be palpated in this area. On transillumination, a bluish shimmering structure (the “blue dot sign”) is often visible (e32). Ultrasonography often reveals a twisted hydatid as a hyper- or hypoechogenic structure between the testis and the epididymis (23, e3–e5) (Figure 4), but demonstration of a hydatid alone is not pathognomonic for torsion, as non-twisted hydatis can be seen as well (e33). Doppler ultrasonography also often reveals accompanying hyperemia of the epididymis (23).

Hydatid torsion is generally treated symptomatically, with bed rest, local cooling, and, in some cases, anti-inflammatory drugs (1, 2). For severe and persistent symptoms, operative removal of the hydatid can be considered in rare cases (1, 2).

Infection

Epididymitis and orchitis

Epididymitis and orchitis are either viral or bacterial infections of the epididymis and testis. Bacterial infections are very rare in children, unlike in adults (24, e34, e35). The symptoms of both conditions generally arise more slowly than those of testicular torsion; unlike in testicular torsion, the testis is neither fixed nor in a higher position (4). The cremasteric reflex is usually preserved. There may be dysuria, indicating a concomitant urinary tract infection (4).

In these disease entities, scrotal ultrasonography reveals hyperemia with increased vascularization, along with enlargement of the epididymis or testis (25, e3). Low RI values may be seen (e5, e10). Further findings may include thickening of the tunica albuginea or an accompanying hydrocele (25, e5).

Urinalysis is an obligate part of the work-up of these infectious conditions (1, 2, e36). In cases of recurrent infection, extended diagnostic evaluation is indicated for the exclusion of structural anomalies (the evaluation might include, for example, renal ultrasonography, uroflowmetry, cystoscopy, and micturition cysto-urethrography) (1–3, e36).

The symptomatic treatment of epididymitis and orchitis resembles that of hydatid torsion. The need

Hydatid torsion

In this entity, small appendages of the testis and epididymis undergo torsion and become ischemic. The clinical manifestations resemble those of testicular torsion.

Hydatid torsion: treatment

Hydatid torsion is generally treated symptomatically, with bed rest, local cooling, and, in some cases, anti-inflammatory drugs.

for antibiotic treatment (e.g. cefuroxime 100 mg/kg/d) in the absence of a demonstrated urinary tract infection is currently debated (e24).

Trauma

Blunt trauma can cause a hematocele or edema of the testis or scrotum (e5, e37, e38). Ultrasonographic imaging is needed to rule out post-traumatic torsion or capsule rupture (e5, e38). The treatment is then decided upon individually in each case.

Systemic disease

The acute scrotum as the initial manifestation of a systemic disease is a challenge for differential diagnosis. When the scrotum is involved in Henoch–Schönlein purpura, the epididymis and testis are often enlarged (e39, e40). Physical examination reveals the pathognomonic petechiae on the calves. Both leukemia and lymphoma can also present with scrotal involvement as their initial manifestation. In such cases, the ultrasonographic findings are generally not definitive, but laboratory tests reveal the diagnosis.

Other diseases

Incarcerated inguinal hernia can cause testicular ischemia, sometimes presenting highly acutely. A thick swelling in the area of the inguinal canal points to the diagnosis. Here, too, ultrasonography is a useful aid in differential diagnosis, complementary to the physical examination. If complete reposition is not possible, immediate surgery is indicated.

Acute idiopathic scrotal edema and emphysema is an entity in which the scrotum becomes swollen for unknown reasons (e41–e43) (Figure 5). The testes are not involved. The marked swelling makes diagnosis by palpation impossible; the condition can only be diagnosed with ultrasonographic imaging.

Acute abdominal inflammation or infection (e.g., appendicitis) can also present with the clinical picture of an acute scrotum. In such cases, the physical examination, laboratory tests, and ultrasonography usually suffice to establish the diagnosis (e44).

Testicular tumors are generally painless. Intratumoral hemorrhage can, however, present with an acute scrotum (e45). Ultrasonography reveals the tumor mass (e5). Germ-cell tumor markers should be determined (alpha-fetoprotein, β -HCG).

Epididymitis and orchitis

These are viral or bacterial infections of the epididymis and testis. Bacterial infections are very rare in children. The symptoms generally arise more slowly than those of testicular torsion.

Figure 5: Ultrasonography of idiopathic scrotal edema in a six-year-old boy. Typically, the scrotal wall is edematous and enlarged on both sides and hyperperfused in places; individual layers can no longer be distinguished

Overview

The acute scrotum is a medical emergency because any unnecessary delay can bring about irreversible damage to the testicular parenchyma. The percentage of patients with an acute scrotum who need emergency scrotal exploration because of testicular torsion is probably less than 20%. It is, therefore, of vital importance to identify the patients who do not need surgery by use of the appropriate diagnostic procedures. A standardized diagnostic approach is recommended in which Doppler ultrasonography plays a central role (Figure 6). The treatment is decided upon on the basis of the findings of the physical examination and Doppler ultrasonography, as soon as these have been performed. Whenever any question remains as to the central perfusion of the testis, emergency surgical exploration is the treatment of choice. When in doubt, explore! (e46)

Conflict of interest statement

The authors declare that no conflict of interest exists.

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Other diseases

Incarcerated inguinal hernia can cause testicular ischemia and can present highly acutely. A thick swelling in the area of the inguinal canal points to the diagnosis.

FIGURE 6

The diagnostic evaluation of the acute scrotum in childhood and adolescence
RI, resistance index; DD, differential diagnosis

REFERENCES

1. Deutsche Gesellschaft für Kinderchirurgie: Das akute Skrotum. Last accessed on 30 April 2012 available at: www.awmf.org/uploads/tx_szleitlinien/006-023I-S1_Aktuelles_Skrotum.pdf
2. Gatti JM, Patrick Murphy J: Current management of the acute scrotum. *Semin Pediatr Surg* 2007; 16: 58–63.
3. Günther P, Schenk JP: Testicular torsion: diagnosis, differential diagnosis, and treatment in children. *Radiologe* 2006; 46: 590–955.
4. Ciftci AO, Senocak ME, Cahit Tanyel F, Buyukpamukcu N: Clinical predictors for differential diagnosis of acute scrotum. *Eur J Pediatr Surg* 2004; 14: 333–8.

5. Rabinowitz R: The importance of the cremasteric reflex in acute scrotal swelling in children. *J Urol* 1884; 132: 89–90.
6. Gunther P, Schenk JP, Wunsch R, et al.: Acute testicular torsion in children: the role of sonography in the diagnostic workup. *Eur Radiol* 2006; 16: 2527–32.
7. Stehr M, Boehm R: Critical validation of colour doppler ultrasound in diagnostics of acute scrotum in children. *Eur J Pediatr Surg* 2003; 13: 386–92.
8. Weber DM, Rosslein R, Fliegel C: Color doppler sonography in the diagnosis of acute scrotum in boys. *Eur J Pediatr Surg* 2000; 10: 235–41.
9. Shaikh FM, Giri SK, Flood HD, Drumm J, Naqvi SA: Diagnostic accuracy of hand-held Doppler in the management of acute scrotal pain. *Ir J Med Sci* 2008; 177: 279–82.
10. Paltiel HJ, Rupich RC, Babcock DS: Maturation changes in arterial impedance of normal testis in boys: Doppler sonographic study. *AJR* 1994; 163: 1189–93.
11. Middleton WD, Thorne DA, Melson GL: Color Doppler ultrasound of the normal testis. *AJR* 1989; 152: 293–7.
12. Kalfa N, Veyrac C, Lopez M, et al.: Multicenter assessment of ultrasound of the spermatic cord in children with acute scrotum. *J Urol* 2007; 177: 297–301.
13. Bartsch G, Frank S, Marberger H, Mikuz G: Testicular torsion: late results with special regard to fertility and endocrine function. *J Urol* 1980; 124: 375–8.
14. Favorito LA, Cavalcante AG, Costa WS: Anatomic aspects of epididymis and tunica vaginalis in patients with testicular torsion. *Int Braz J Urol* 2004; 30: 420–4.
15. Chmelnik M, Schenk JP, Hinz U, Holland-Cunz S, Günther P: Testicular torsion: sonomorphological appearance as a predictor for testicular viability and outcome in neonates and children. *Pediatr Surg Int* 2010; 26: 281–6.
16. Kaye JD, Shapiro EY, Levitt SB, et al.: Parenchymal echo texture predicts testicular salvage after torsion: potential impact on the need for emergent exploration. *J Urol* 2008; 180: 1733–6.
17. Waldert M, Klatte T, Schmidbauer J, Remzi M, Lackner J, Marberger M: Color Doppler sonography reliably identifies testicular torsion in boys. *Urology* 2010; 75: 1170–4.
18. Bentley DF, Ricchiuti DJ, Nasrallah PF, McMahon DR: Spermatic cord torsion with preserved testis perfusion: initial anatomical observations. *J Urol* 2004; 172: 2373–6.
19. Kaye JD, Levitt SB, Friedmann SC, Franco I, Gitlin J, Palmer LS: Neonatal torsion. a 14-year experience and proposed algorithm for management. *J Urol* 2008; 179: 2377–83.
20. Sorensen MD, Galansky SH, Striegl AM, Mevorach R, Koyle MA: Perinatal extravaginal torsion of the testis in the first month of life is a salvageable event. *Urology* 2003; 62: 132–4.
21. Aktas BK, Bulut S, Bulut S, et al.: The effects of N-acetylcysteine on testicular damage in experimental testicular ischemia/reperfusion injury. *Pediatr Surg Int* 2010; 26: 293–8.
22. Cay A, Alver A, Küçük M, et al.: The effects of N-acetylcysteine on antioxidant enzyme activities in experimental testicular torsion. *J Surg Res* 2006; 13: 199–203.
23. Sellars ME, Sidhu PS: Ultrasound appearance of testicular appendages: Pictorial review. *Eur Radiol* 2003; 13: 127–35.

Testicular tumors

Testicular tumors are generally painless. Intratumoral hemorrhage can present with an acute scrotum. Ultrasonography reveals the tumor mass. Germ-cell tumor markers should be determined.

Overview

If any question remains as to the central perfusion of the testis, emergency surgical exploration is the treatment of choice. When in doubt, explore!

24. Somekh E, Gorenstein A, Serour F: Acute epididymitis in boys: Evidence of a post-infectious etiology. *J Urol* 2004; 171: 391–4.
25. Farriol VG, Comella XP, Agromayor EG, Creixams XS, Martinez De La Torre IB: Gray-scale and power doppler sonographic appearances of acute inflammatory diseases of the scrotum. *J Clin Ultrasound* 2000; 28: 67–76.

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The solutions to the following questions will be published in issue 33–34/2012.

The CME unit “Confusional States in the Elderly” (Issue 21/2012) can be accessed until 6 July 2012. For issue 29–30/2012, we plan to offer the topic “Euthyroid Goiter With and Without Nodules—Investigation and Treatment.”

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Please answer the following questions to participate in our certified Continuing Medical Education program. Only one answer is possible per question. Please select the answer that is most appropriate.

Question 1

What is the annual incidence of testicular torsion in young males?

- a) 1: 500
- b) 1: 4000
- c) 1: 10 000
- d) 1: 20 000
- e) 1: 100 000

Question 2

In the history of a patient with an acute scrotum, what sign should be asked about in particular?

- a) petechiae
- b) nevus lenticularis
- c) erythema
- d) milia
- e) comedones

Question 3

What reflex should be tested as part of the diagnostic evaluation of the acute scrotum?

- a) the anal reflex
- b) the pupillary light reflex
- c) the abdominal wall reflex
- d) the knee-jerk reflex
- e) the cremasteric reflex

Question 4

Which of the following is essential in the ultrasonographic evaluation of the acute scrotum, aside from the expertise of the examiner?

- a) a 1.5–3.5 MHz linear transducer with Doppler or power-Doppler function
- b) a 2–4 MHz linear transducer with Doppler or power-Doppler function
- c) a 2–5 MHz linear transducer with Doppler or power-Doppler function
- d) a 4–7 MHz linear transducer with Doppler or power-Doppler function
- e) a 7–13 MHz linear transducer with Doppler or power-Doppler function

Question 5

A six-year-old boy presents with a painful acute scrotum but feels better rapidly thereafter. Doppler ultrasonography reveals a hyperperfused testis. What is your suspected diagnosis?

- a) blunt trauma
- b) testicular tumor
- c) intermittent testicular torsion
- d) appendicitis
- e) incarcerated inguinal hernia

Question 6

Palpation of the acute scrotum of a 10-year-old boy reveals maximum tenderness above the testis. Transillumination reveals a bluish structure. Ultrasonography reveals a round, hyperechogenic, non-perfused structure next to the upper pole of the testis. What is the most likely diagnosis?

- a) scrotal edema
- b) hydatid torsion
- c) epididymitis
- d) intravaginal testicular torsion
- e) neonatal testicular torsion

Question 7

A standardized diagnostic evaluation including Doppler ultrasonography in a patient with an acute scrotum fails to demonstrate adequate central perfusion of the testis with certainty. In this situation, what is the treatment of choice?

- a) emergency surgical exploration of the testis
- b) intravenous antibiotics
- c) perfusion-promoting drugs
- d) bed rest
- e) measurement of tumor markers

Question 8

Doppler ultrasonography reveals a scrotal wall that is expanded by edema. Individual layers can no longer be distinguished. The central perfusion of the testis is within normal limits. What is the most likely diagnosis?

- a) hematocele
- b) hydatid torsion
- c) idiopathic scrotal edema
- d) intermittent torsion
- e) orchitis

Question 9

Which of the following can be used to treat hydatid torsion?

- a) anti-inflammatory drugs
- b) antibiotics
- c) anti-diuretic drugs
- d) anti-arrhythmic drugs
- e) anti-emetic drugs

Question 10

What disease can present with scrotal involvement as its initial manifestation?

- a) diabetes
- b) leukemia
- c) hypertension
- d) plasmocytoma
- e) rheumatoid arthritis

CONTINUING MEDICAL EDUCATION

The Acute Scrotum in Childhood and Adolescence

Patrick Günther and Iris Rübben

eREFERENCES

- e1. McAndrew HF, Pemberton R, Kikiros CS, Gollow I: The incidence and investigation of acute scrotal problems in children. *Pediatr Surg Int* 2002; 18: 435–7.
- e2. Nelson CP, Williams JF, Bloom DA: The cremasteric reflex: a useful but imperfect sign in testicular torsion. *J Pediatr Surg* 2003; 38: 1248–9.
- e3. Baldisserotto M: Scrotal emergencies. *Pediatr Radiol* 2009; 39: 516–21.
- e4. Hormann M, Balassy C, Philipp MO, Pumberger W: Imaging of the acute scrotum in children. *Eur Radiol* 2004; 14: 974–83.
- e5. Pavlica P, Barozzi L: Imaging of the acute scrotum. *Eur Radiol* 2001; 11: 220–8.
- e6. Baker LA, Sigman D, Mathews RI, Benson J, Docimo SG: An analysis of clinical outcomes using color doppler testicular ultrasound for testicular torsion. *Pediatrics* 2000; 105: 604–7.
- e7. Kravchick S, Cytron S, Leibovici O, et al.: Color Doppler sonography: Its real role in the evaluation of children with highly suspected testicular torsion. *Eur Radiol* 2001; 11: 1000–5.
- e8. Pepe P, Panella P, Pennisi M, Aragona F: Does color Doppler sonography improve the clinical assessment of patients with acute scrotum? *Eur J Radiol* 2006; 60: 120–4.
- e9. Zoller G, Gugler A, Ringert RH: „False positive“ testicular perfusion in testicular torsion in power Doppler ultrasound. *Urologe A* 2000; 39: 251–3.
- e10. Jee WH, Choe BY, Byun JY, Shinn KS, Hwang TK: Resistive index of the intrascrotal artery in scrotal inflammatory disease. *Acta Radiol* 1997; 38: 1026–30.
- e11. Dogra VS, Rubens DJ, Gottlieb RH, Bhatt S: Torsion and beyond: new twists in scrotal Doppler evaluation of the scrotum. *J Ultrasound Med* 2004; 23: 1077–85.
- e12. Arce JD, Cortes M, Vargas JC: Sonographic diagnosis of acute spermatic cord torsion. Rotation of the cord: a key of the diagnosis. *Pediatr Radiol* 2002; 32: 485–91.
- e13. Kalfa N, Veyrac C, Baud C, Couture A, Averous M, Galifer RB: Ultrasonography of the spermatic cord in children with testicular torsion: impact in the surgical strategy. *J Urol* 2004; 172: 1692–5.
- e14. Frush DP, Babcock DS, Lewis AG, et al.: Comparison of color doppler sonography and radionuclide imaging in different degrees of torsion in rabbit testes. *Acad Radiol* 1995; 2: 945–51.
- e15. Landa HM, Gyllys-Morin V, Mattery RF, et al.: Detection of testicular torsion by magnetic resonance imaging in a rat model. *J Urol* 1988; 140: 1178–80.
- e16. Nussbaum Blask AR, Bulas D, Shalaby-Rana E, Rushton G, Shao C, Majd M: Color Doppler sonography and scintigraphy of the testis: A prospective, comparative analysis in children with acute scrotal pain. *Pediatr Emerg Care* 2002; 18: 67–71.
- e17. Trambert MA, Mattrey RF, Levine D, Berthoty DP: Subacute scrotal pain: evaluation of torsion versus epididymitis with MR imaging. *Radiology* 1990; 175: 53–6.
- e18. Watanabe Y, Dohke M, Ohkubo K, et al.: Scrotal disorders: evaluation of testicular enhancement patterns at dynamic contrast-enhanced subtraction MR imaging. *Radiology* 2000; 217: 219–27.
- e19. Dunne PJ, O'Loughlin BS: Testicular torsion: time is the enemy. *ANZ Surg* 2000; 70: 441–2.
- e20. Caesar RE, Kaplan GW: Incidence of the bell-clapper deformity in an autopsy series. *Urology* 1994; 44: 114–6.
- e21. Beni-Isreal T, Goldman M, Bar Chaim S, Kozer E: Clinical predictors for testicular torsion as seen in the pediatric ED. *Am J Emerg Med* 2010; 28: 786–9.
- e22. Traubici J, Daneman Alan, Navarro O, Mohanta A, Garcia C: Testicular Torsion in Neonates and Infants: Sonographic Features in 30 Patients. *AJR* 2003; 80: 1143–5.
- e23. Yagil Y, Naroditsky I, Milhem J, et al.: Role of Doppler ultrasonography in the triage of acute scrotum in the emergency department. *J Ultrasound Med* 2010; 29: 11–21.
- e24. Stillwell TJ, Kramer SA: Intermittent testicular torsion. *Pediatrics* 1986; 77: 908–11.
- e25. Al-Salem AH: Intrauterine testicular torsion: a surgical emergency. *J Pediatr Surg* 2007; 42: 1887–91.
- e26. Cuervo JL, Grillo A, Vecchiarelli C, Osio C, Prudent L: Perinatal testicular torsion: a unique strategy. *J Pediatr Surg* 2007; 42: 699–703.
- e27. Cumming DC, Hyndman CW, Deacon JS: Intrauterine testicular torsion: not an emergency. *Urology* 1979; 14: 603–4.
- e28. Das S, Singer A: Controversies of perinatal torsion of the spermatic cord: a review, survey and recommendations. *J Urol* 1990; 143: 231–3.
- e29. Yerkes EB, Robertson FM, Gitlin J, Kaefer M, Cain MP, Rink RC: Management of perinatal torsion: today, tomorrow or never? *J Urol* 2005; 174: 1579–83.
- e30. Snyder HM, Diamond DA: In Utero/Neonatal Torsion: Observation Versus Prompt Exploration. *J Urol* 2010; 183: 1675–7.
- e31. Nandi B, Murphy FL: Neonatal testicular torsion: a systematic literature review. *Pediatr Surg Int* 2011; 27: 1037–40.
- e32. Mäkelä E, Lahdes-Vasama T, Rajakorpi H, Wikström S: A 19-year review of paediatric patients with acute scrotum. *Scand J Surg* 2007; 96: 62–6.
- e33. Baldisserotto M, de Souza JC, Pertence AP, Dora MD: Color Doppler sonography of normal and torsed testicular appendages in children. *AJR Am J Roentgenol* 2005; 184: 1287–92.
- e34. Halachmi S, Toubi A, Meretyk S: Inflammation of the testis and epididymis in an otherwise healthy child: is it a true bacterial urinary tract infection? *J Pediatr Urol* 2006; 2: 386–9.
- e35. Graumann LA, Dietz HG, Stehr M: Urinalysis in children with epididymitis. *Eur J Pediatr Surg* 2010; 20: 247–79.
- e36. Siegel A, Snyder H, Duckett JW: Epididymitis in infants and boys: underlying urogenital anomalies and efficacy of imaging modalities. *J Urol* 1987; 138: 1100–3.

- e37. Diamond DA, Borer JG, Peters CA, et al.: Neonatal scrotal Haematoma: mimicker of neonatal testicular torsion *BJU Int* 2003; 91: 675–7.
- e38. Deurdulian C, Mittelstaedt CA, Chong WK, Fielding JR: US of acute scrotal trauma: optimal technique, imaging findings, and management. *Radiographics* 2007; 27: 357–69.
- e39. Ben-Sira L, Laor T: Severe scrotal pain in boys with Henoch-Schonlein purpura: incidence and sonography. *Pediatr Radiol* 2000; 30: 125–8.
- e40. Hara Y, Tajiri T, Matsuura K, Hasegawa A: Acute scrotum caused by Henoch-Schonlein purpura. *Int J Urol* 2004; 11: 578–80.
- e41. Klin B, Lotan G, Efrati Y, Zlotkevich L, Strauss S: Acute idiopathic scrotal edema in children revisited. *J Pediatr Surg* 2002; 37: 1200–2.
- e42. Lee A, Park SJ, Lee HK, Hong HS, Lee BH, Kim DH: Acute idiopathic scrotal edema: ultrasonographic findings at an emergency unit. *Eur Radiol* 2009; 19: 2075–80.
- e43. Smet MH, Palmers M, Oyen R, Breysen L: Ultrasound diagnosis of infantile scrotal emphysema. *Pediatr Radiol* 2004; 34: 824–6.
- e44. Singh S, Adivarekar P, Karmarkar SJ: Acute scrotum in children: A rare presentation of acute, non-perforated appendicitis. *Pediatr Surg Int* 2003; 19: 298–9.
- e45. Marulaiah M, Gilhotra A, Moore L, Boucaut H, Goh DW: Testicular and Paratesticular Pathology in Children: a 12-Year Histopathological Review. *World J Surg* 2010; 34: 969–74.
- e46. Thomas DFM: The acute scrotum. In: Thomas DFM, Duffy PG, Rickwood AMK, eds: London: Informa Healthcare UK 2008, 265–74.