Role of Doppler Ultrasonography in the Triage of Acute Scrotum in the Emergency Department

Yael Yagil, MHA, MD, Inna Naroditsky, MD, Jumana Milhem, BSc, Ronit Leiba, MSc, Maxim Leiderman, MD, Shadie Badaan, MD, Diana Gaitini, MD

Objective. The purpose of this study was to examine the triage role of scrotal Doppler ultrasonography (DUS) as the primary preoperative diagnostic tool in patients presenting to the emergency department (ED) with acute scrotum. ***Methods.*** Patients who presented to the ED with acute scrotum and underwent scrotal DUS in the ultrasound unit over a 3-year period (2004–2007) were included in the study. Patient characteristics, DUS findings, and clinical management were retrospectively collected and reviewed. Doppler ultrasonographic diagnoses were compared with histopathologic findings for patients who underwent exploration and with final diagnoses at the time of discharge for patients undergoing medical treatment. ***Results.*** A total of 620 consecutive patients with 669 DUS examinations were included. The most common scrotal DUS diagnoses were epididymitis, hydrocele, varicocele, and orchitis. Scrotal trauma was present in 77 cases. Hospitalization followed the initial ED evaluation for 155 patients; 68 underwent surgery. Testicular torsion was ultrasonographically suspected in 20 patients and confirmed in 18. Scrotal malignancy was incidentally diagnosed in 13 patients and testicular hematoma in 8. Doppler ultrasonography for the diagnosis of testicular torsion had 94% sensitivity, 96% specificity, 95.5% accuracy, an 89.4% positive predictive value (PPV), and a 98% negative predictive value (NPV). Doppler ultrasonography for the diagnosis of testicular malignancy had 92% sensitivity, 95% specificity, 94% accuracy, a 78.5% PPV, and a 98% NPV. ***Conclusions.*** Scrotal DUS is a highly sensitive preoperative diagnostic tool, thereby validating its routine use in the initial triage of patients with acute scrotum presenting to the ED. ***Key words:*** Doppler ultrasonography; emergency; hematoma; malignancy; testis; torsion.

Abbreviations
AML, acute myeloid leukemia; DUS, Doppler ultrasonography; ED, emergency department; NPV, negative predictive value; PPV, positive predictive value

Received September 10, 2009, from the Departments of Medical Imaging (Y.Y., M.L., D.G.), Pathology (I.N.), Quality Assurance (R.L.), and Urology (S.B.), Rambam Health Care Campus, Haifa, Israel; and Technion Faculty of Medicine, Israel Institute of Technology, Haifa, Israel (J.M., D.G.). Revision requested September 23, 2009. Revised manuscript accepted for publication October 5, 2009.

This study was presented in part at the Radiological Society of North America Annual Meeting; November 30–December 5, 2008; Chicago, Illinois.

Address correspondence to Diana Gaitini, MD, Department of Medical Imaging, Rambam Health Care Campus, PO Box 9602, Ha'Aliya St 8, 31096 Haifa, Israel.
E-mail: d_gaitini@rambam.health.gov.il

CME *Article includes CME test*

Acute scrotum refers to the sudden onset of scrotal erythema, swelling, or pain. It is not a rare condition in the emergency department (ED). Orchiepididymitis, torsion of the testis or testicular appendages, testicular hematoma secondary to trauma, an incarcerated scrotal hernia, and testicular malignancy are the main entities in the differential diagnosis.[1,2] A careful history, a thorough physical examination, and appropriate diagnostic tests can substantially narrow the differential diagnosis. The diversity of etiologies related to this clinical presentation makes the diagnosis a difficult one, and an objective and reliable imaging procedure is demanded. Doppler ultrasonography (DUS) is a noninvasive examination that lacks ionizing radiation and is highly sensitive in the detection of

intrascrotal abnormalities[3]; therefore, it is considered nowadays the first imaging modality for the assessment of acute scrotum. A DUS study includes gray scale imaging and color and spectral Doppler flow of the scrotal contents, mainly the testis and epididymis. By enabling the distinction between surgical emergencies, such as testicular torsion and traumatic testicular rupture, which mandate immediate scrotal exploration to prevent testicular loss, and surgical nonemergencies and nonsurgical entities, scrotal DUS has become the standard diagnostic test on which the therapeutic approach in patients with acute scrotum is based.[4–6]

The aim of this study was to examine the performance of scrotal DUS as a triage tool for preoperative diagnosis in patients presenting to the ED with acute scrotum.

Materials and Methods

Study Population

The study population included all consecutive patients presenting to the ED with acute scrotum (isolated scrotal erythema, swelling, pain, or a combination of any of these symptoms) who underwent scrotal DUS from October 2004 to October 2007. The study design was of a retrospective nature, and data pertaining to patient characteristics, DUS examinations, and clinical management were obtained from our computerized medical records. Institutional Review Board approval was obtained. A waiver of informed consent was granted for this retrospective study.

Patient Characteristics

Data collected included age, medical history, and clinical symptoms at presentation.

Doppler Ultrasonographic Examinations

Scrotal DUS examinations were performed at the ultrasound unit of the Department of Medical Imaging. High-resolution linear array transducers (7–12 and 5–17 MHz) with HDI and iU22 ultrasound equipment (Philips Healthcare, Bothell, WA) were used. Lower-resolution linear (4–8 MHz) and convex (5–8 MHz) transducers were used for examinations of enlarged scrotums. Examinations were performed with the patient supine on transverse and longitudinal scrotal axes. On B-mode gray scale images, the testis and epididymis size, texture, and focal findings were evaluated and compared with the contralateral side. Color, power, and pulsed Doppler ultrasound were applied to verify and characterize blood flow (arterial and venous) in the testes and epididymis. Extratesticular scrotal findings were also searched for.

The examinations were performed on a 24-hour basis either by a sonographer followed by an attending radiologist or by a resident in radiology with at least 6 months of training in ultrasound. The examinations were evaluated on screen at the time of the procedure, and images were also sent to a picture archiving and communications system for later review. Examinations performed by residents during off hours were reviewed by the attending radiologist either immediately through a home computer Internet connection or within a few hours on the following day.

For the purpose of this study, the radiologic reports of all scrotal DUS examinations performed during the study period were collected and retrospectively reviewed, with special focus on signs of testicular torsion (testis and appendages) and detorsion, orchitis, epididymitis and scrotal edema, testicular trauma, testicular and extratesticular masses, hydrocele, and varicocele. Specifically, ultrasonographic features sought for testicular torsion were testicular swelling, decreased echogenicity, and absent or diminished testicular blood flow. Features suggestive of testicular hematoma were an intact tunica albuginea with a testicular hyperechoic or hypoechoic lesion without internal vascularity along with a relevant clinical history. A finding of a solid mass within the testicular parenchyma with internal vascularity was considered suggestive of a testicular tumor. When the report included more than 1 entity, or a differential diagnosis was given, all of the ultrasonographic findings were registered for the referred DUS examination.

Clinical Management

Conservative or surgical management after the clinical evaluation and DUS examination was assessed. Patients were either discharged from the ED or admitted to the hospital. The hospitalized subgroup included patients admitted either

after the first ED visit or after a second ED visit during the following month with the same clinical condition.

Surgical Findings

Surgical reports, pathologic findings, and final diagnoses at discharge were registered. The DUS diagnosis was compared with the final diagnosis at discharge to determine whether the preoperative diagnosis was correct or had been included in the differential diagnosis.

Statistical Analysis

All data were collected and analyzed with descriptive statistics using Excel software (Microsoft Corporation, Redmond, WA). The sensitivity, specificity, accuracy, positive predictive value (PPV), and negative predictive value (NPV) of DUS for the preoperative diagnosis of testicular torsion, malignancy, and hematoma were calculated. The statistical analyses were performed with the Pearson χ^2 test and SPSS version 14 software for Windows (SPSS Inc, Chicago, IL).

True-positive cases included patients with a positive imaging diagnosis of testicular torsion, malignancy, or hematoma confirmed by surgical and pathologic reports. False-positive cases included patients with a positive imaging diagnosis of testicular torsion, malignancy, or hematoma and negative pathologic findings. True-negative cases included patients with a negative imaging diagnosis of testicular torsion, malignancy, or hematoma and negative surgical findings. False-negative cases included patients with a negative imaging diagnosis who underwent surgical exploration and had positive pathologic findings for testicular torsion, malignancy, or hematoma.

Results

This retrospective study included 620 patients who presented to the ED with acute scrotum and underwent scrotal DUS over a 3-year period. Forty-five patients underwent more than 2 DUS examinations on different ED visits, for a total of 669 scrotal DUS examinations performed. Fifty-five percent of the examinations were performed by the resident in radiology on duty, and 45% were performed by attending radiologists.

The mean age of the patients ± SD was 21.9 ± 16.6 years (range, 2 months–95 years). Data regarding medical histories and clinical presentations to the ED are depicted in Table 1. Most patients had no relevant medical history related to previous testicular conditions. The clinical presentations included scrotal pain, swelling, and erythema. In one-third of the cases, more than 1 clinical sign was present. Scrotal trauma, mainly blunt trauma, was reported in 77 cases (11%).

Among the 669 scrotal DUS examinations performed in 620 patients, in 514 cases (77%), patients were discharged from the ED on the basis of clinical evaluation and DUS findings. In 155 cases (23%), hospitalization followed the initial ED evaluations, 138 (89%) on the first ED visit and 17 (11%) on a second visit during the following month with the same clinical condition.

Scrotal DUS findings for the 669 examinations performed with comparison between patients discharged from the ED and those admitted to the hospital after initial ED evaluations are shown in Table 2. Ultrasonographic findings for the hospitalized patients were similar to the findings for those discharged from the ED, with additional findings consistent with testicular torsion, malignancy, and hematoma.

Sixty-eight of the patients admitted (44%) underwent surgical exploration. Table 3 shows the diagnostic indications for surgical exploration among this subgroup of patients.

Table 1. Patients' Medical Backgrounds and Clinical Presentations to the ED

Background and Presentation	n	%
Medical history		
None	556	90
Testicular malignancy	12	2
Nontesticular malignancy	8	1
Orchiectomy for malignant and nonmalignant processes	18	3
Inguinal hernia repair	16	2
Hydrocelectomy	10	2
Clinical presentation		
Scrotal pain	598	89
Scrotal swelling	267	40
Scrotal erythema	70	11
Clinical side distribution		
Right hemiscrotum	272	41
Left hemiscrotum	304	45
Bilateral	93	14

Testicular Torsion

Testicular torsion was ultrasonographically diagnosed in 20 patients aged between 1 and 25 years (average, 16 years). Testicular blood flow was absent in 16 of 18 cases, and in 2 cases, the involved testicle was hypovascular relative to the contralateral side. In 7 cases, the testicle was enlarged. One patient underwent a scrotal radionuclide study for a clinical and ultrasonographic diagnostic discrepancy, which excluded testicular torsion and precluded surgery. A total of 20 patients underwent surgical exploration for suspected torsion, and DUS was indicative of torsion in 19 cases. Table 4 depicts the surgical outcomes in these patients. Torsion was surgically confirmed in 18 patients. In 13 cases, the testicle was salvaged, and the patients underwent orchiopexy. Figure 1 shows an example of one such case in which testicular torsion was suspected by DUS and confirmed by surgery. The single false-negative DUS diagnosis of testicular torsion occurred in a 3-year-old patient with a DUS diagnosis of testicular detorsion. In this case, the involved testicle appeared enlarged with existent yet slightly diminished blood flow relative to the contralateral testicle. Because of a high clinical suspicion of torsion, surgery was performed, confirming the clinical diagnosis of torsion. In the 2 cases with false-positive DUS diagnoses of torsion, the removed testicles were necrotic but not because of testicular torsion: testicular necrosis following traumatic rupture of the tunica albuginea in 1 case and an undescended necrotic testis adjacent to an incarcerated inguinal hernia in the other.

The calculated performance values for DUS in the diagnosis of testicular torsion were 94% sensitivity, 96% specificity, 95.5% accuracy, an 89.4% PPV, and a 98% NPV (Table 4).

Testicular Malignancy

Sonographic findings suggestive of scrotal malignancy were reported in 20 patients: 17 with testicular malignancy and 3 with extratesticular malignancy. For 3 patients, in whom further clinical and follow-up DUS evaluations as well as seronegative tumor markers ruled out malignancy, surgery was spared. In total, 17 patients underwent surgery (14 for suspected testicular malignancy and 3 for extratesticular malignancy), and Table 4 depicts the surgical outcomes. Scrotal malignancy was pathologically diagnosed in 13 patients: 12 with testicular malignancy and 1 with extratesticular malignancy. False-positive DUS diagnoses of testicular malignancy occurred in 3 patients. In 2

Table 2. Doppler Ultrasonographic Diagnoses for Patients With Acute Scrotum Referred From the ED: Comparison Between Patients Discharged From the ED and Admitted to the Hospital After Initial ED Evaluation

	Discharged From ED (n = 514)		Hospitalized (n = 155)	
DUS Finding	**n**	**%**	**n**	**%**
Hydrocele	196	38	77	50
Epididymitis	180	35	45	29
Scrotal edema	94	18	54	35
Orchitis	63	12	30	19
Varicocele	107	21	20	13
Testicular torsion	0	0	20	13
Testicular malignancy	2	0.4	17	11
Testicular hematoma	4	1	12	8
Inguinal hernia	10	2	12	8
Extratesticular mass	18	4	10	6
Undescended testis	8	2	10	6
Rupture of tunica albuginea	1	0.2	8	5
Scrotal abscess	2	0.4	6	4
Scrotal hematoma	8	2	6	4
Testicular necrosis	1	0.2	5	3
Torsion of appendix testis	7	1	4	3
Fournier gangrene	0	0	2	1
Testicular detorsion	6	1	2	1
Open scrotal wound	2	0.4	2	1
Scrotal cellulitis	2	0.4	0	0

Table 3. Clinical and DUS Diagnostic Indications for Surgical Exploration Among the Hospitalized Subgroup of Patients

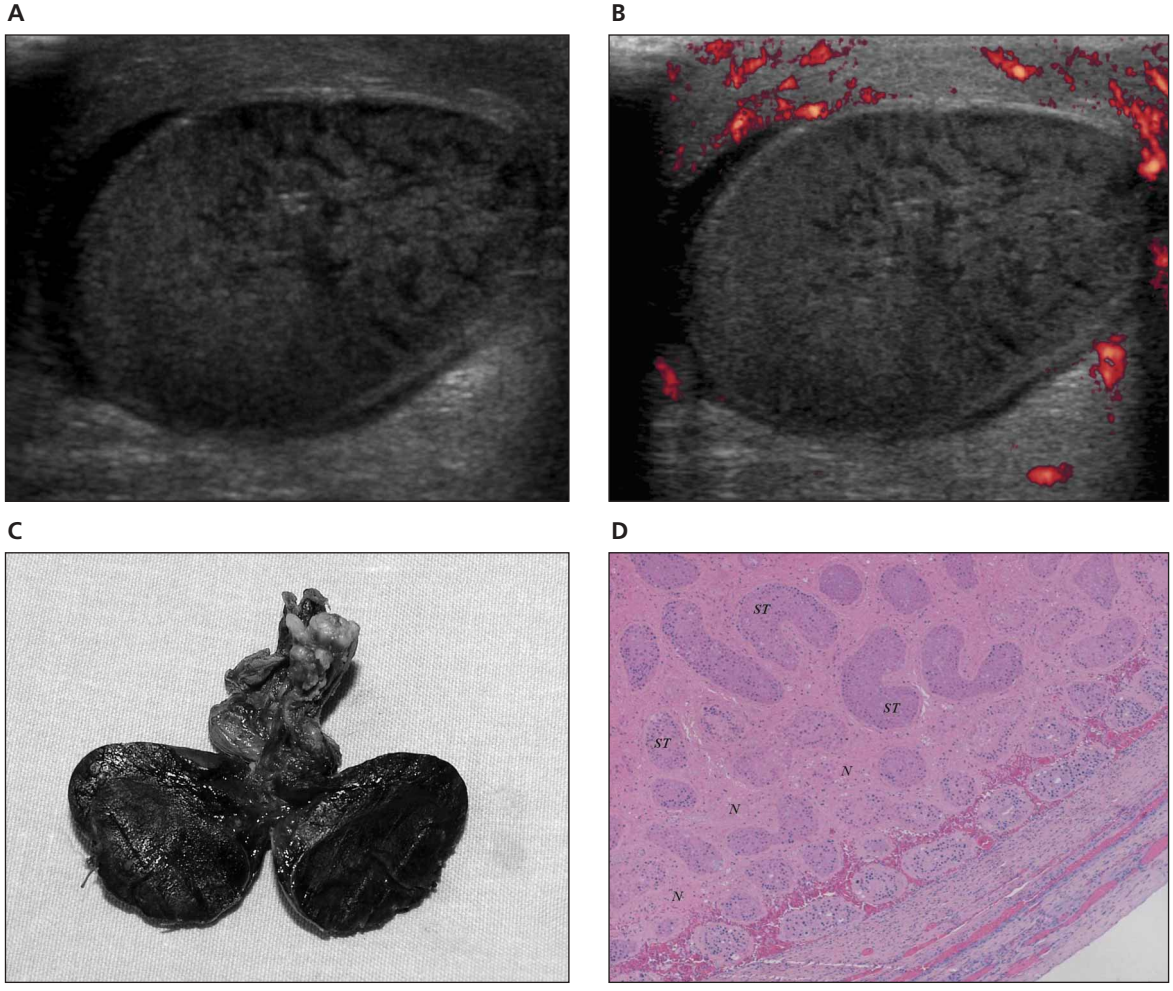
Diagnostic Indication (n = 68)	**n**
Testicular torsion	20
Testicular malignancy	11
Hydrocele	8
Inguinal hernia	8
Testicular hematoma with suspected rupture of tunica albuginea	5
Testicular mass (testicular hematoma or malignancy)	3
Scrotal abscess	3
Extratesticular tumor	3
Undescended testis	3
Orchiepididymitis	1
Fournier gangrene	1
Scrotal hematoma	1
Funiculocele	1

Table 4. Performance of DUS in the Diagnosis of Testicular Torsion, Malignancy, and Hematoma

DUS Finding	True +, n	True –, n	False +, n	False –, n	Sensitivity, %	Specificity, %	Accuracy, %	PPV, %	NPV, %
Testicular torsion	17	48	2	1	94	96	95.5	89	98
Testicular malignancy	11	53	3	1	92	95	94	78.5	98
Testicular hematoma	7	60	1	0	100	98	98.5	87.5	100

cases, DUS showed a well-defined heterogeneous testicular mass with partial vascularity, and hemorrhage from an underlying tumor was suspected. Although the macroscopic surgical findings were also highly suggestive of malignancy, histopathologic analysis indicated merely testicular hematoma. In the third case, histopathologic analysis showed signs of atrophy and fibrosis without malignancy. The single false-negative diagnosis of testicular malignancy occurred in a 30-year-old patient in whom a large mass filling most of the hemiscrotum was seen and mistakenly described as an extratesticular mass. Histopathologic findings were compatible with a large mixed germ cell tumor replacing most of the testicular tissue but no

Figure 1. Complete torsion of the testis. **A**, Gray scale longitudinal sonogram showing a swollen hypoechoic testicle. **B**, Color Doppler image showing absence of flow in the testis, compatible with complete torsion. **C**, Macroscopic surgically removed specimen showing hemorrhagic tissue in the testis. **D**, Histopathologic sample showing hemorrhagic necrosis (N) with remnant seminiferous tubules (ST; hematoxylin-eosin, original magnification ×50).



extratesticular malignancy. This was 1 of the 2 false-positive DUS diagnoses of extratesticular malignancy. The second occurred in a patient with a pathologic diagnosis of chronic purulent epididymitis and fibrosis.

The histologic types of testicular malignancy identified are shown in Table 5. An example of secondary leukemic spread to the testis is depicted in Figure 2. Interestingly, 1 patient had a diagnosis of bilateral testicular involvement of non–germ cell and mixed germ cell tumors (Figure 3). The single case of an ultrasonographically diagnosed extratesticular tumor proved to be metastatic spread of mucinous adenocarcinoma of the colon to the testicular cord and tunica albuginea.

The mean age of the patients with scrotal malignancy was 40 ± 17.9 years (range, 20–74 years), and that of the patients with testicular malignancy was 38 ± 17.5 years (range, 20–74 years), which was almost twice as old as the mean age of the patients without malignancy (21.5 ± 16.5 years; range, 2 months–95 years; $P < .0001$).

The calculated performance values for DUS in the diagnosis of testicular malignancy were 92% sensitivity, 95% specificity, 94% accuracy, a 78.5% PPV, and a 98% NPV (Table 4).

Testicular Hematoma

Testicular hematoma was ultrasonographically suggested in 12 cases, 8 of which had a suspected tear of the tunica albuginea. In all but 1 case, a history of scrotal trauma was reported. Four of the 12 patients were treated conservatively and discharged after several days of hospitalization. No long-term follow-up was available for these patients. Eight patients underwent surgical exploration of the scrotum: 5 for ultrasonographically suspected testicular hematoma with a tear of the tunica albuginea and 3 indeterminate cases in which a malignancy could not be ruled out. Table 4 shows the surgical outcomes in this subset of patients. Testicular hematoma was surgically confirmed in 7 cases. Figure 4 shows an example of such a case. Testicular laceration with a tear of the tunica albuginea was confirmed in 4 cases. The single false-positive DUS diagnosis of testicular hematoma occurred in a 37-year-old patient in whom testicular seminoma was diagnosed by pathologic analysis. The calculated performance values of DUS in the diagnosis of testicular hematoma were 100% sensitivity, 98% specificity, 98.5% accuracy, an 87.5% PPV, and a 100% NPV (Table 4).

Table 5. Histologic Types of Testicular Malignancy Identified Among the Surgically Explored Subgroup of Patients

Histologic Type	n
Mixed germ cell tumor	5
Embryonal cell tumor	2
Seminoma	2
Secondary leukemic spread	2
Non–germ cell tumor	1
Necrotic specimen	1

Discussion

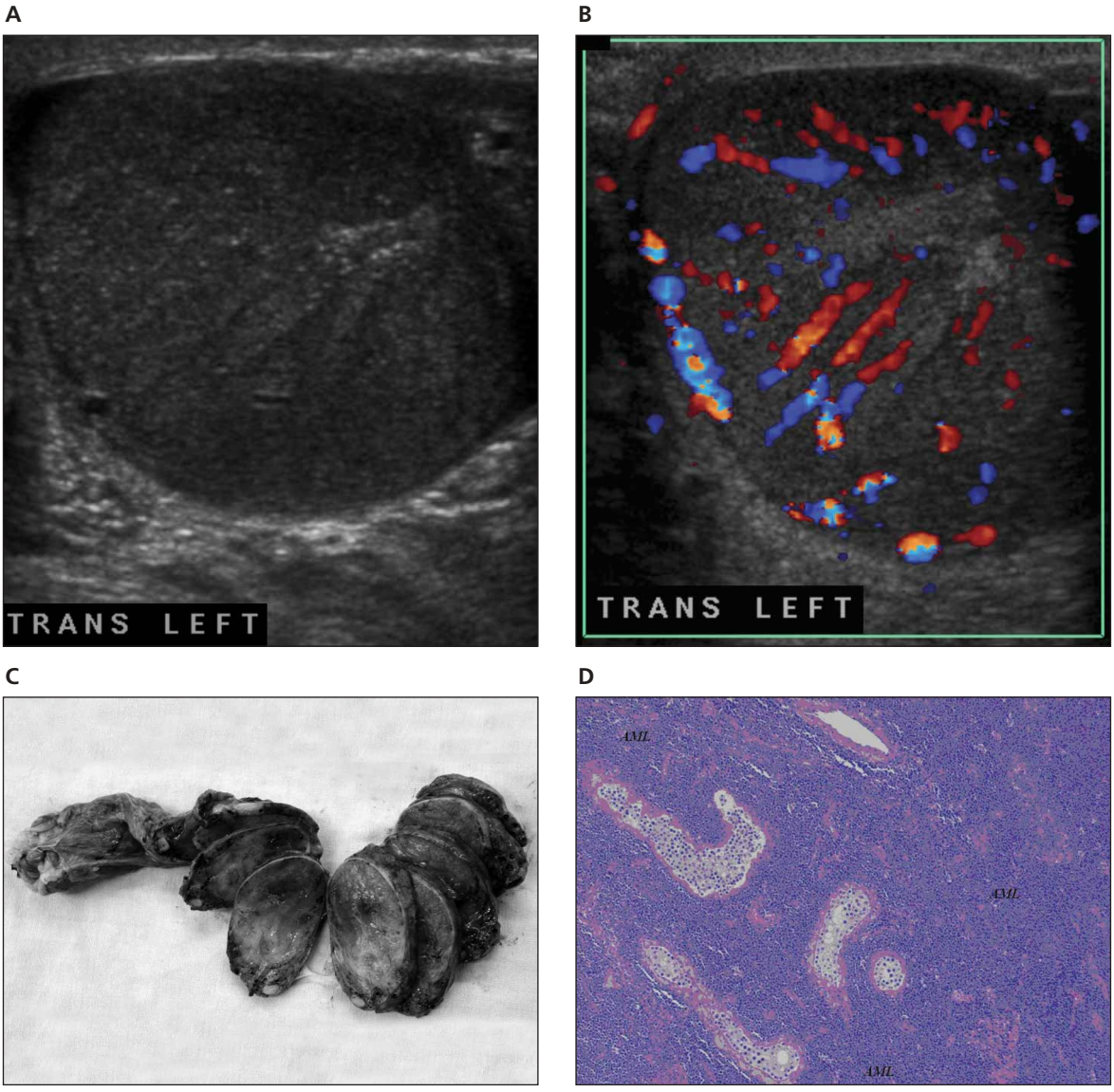
Acute scrotum is a diagnostic dilemma because of the diverse etiologies and extreme local tenderness, which makes clinical examination very difficult.[7] The main goal is to differentiate between surgical emergencies and nonsurgical problems. Doppler ultrasonography is considered the primary imaging modality for such evaluations.[1,8]

The main diagnosis to be confirmed or ruled out by DUS is testicular torsion, which warrants emergency surgical intervention. In the literature, the reported diagnostic performance values for DUS of testicular torsion varied from 69% to 86% sensitivity, 87% to 100% specificity, 73% to 97% accuracy, a 100% PPV, and a 97.5% NPV.[9–13] A key difference between our study and previous works was that a scrotal DUS examination was performed in all cases after a clinical history intake and physical examination, regardless of the degree of clinical suspicion of testicular torsion, and in none did surgery directly ensue. This may account for the relatively higher sensitivity value found in our study (94%) compared with previous reports. The high specificity value (96%) may be attributed to the study population, composed mainly of adolescents and young men in whom scrotal examinations were technically adequate, and the fact that the studies were either performed or reviewed in proximity to the time of the examinations by ultrasound-trained attending radiologists. In some instances, patients were taken to the operating room solely on the basis of the on-call resident's impression, and there were

no instances in which the attending radiologist, who later reviewed the images, disagreed with the resident's initial diagnosis.

Zini et al[10] suggested that scrotal ultrasonography should not be used as an emergency investigation, and surgical exploration of the scrotum in all cases of painful testes must be performed urgently without a preoperative morphologic assessment. In our institution, patients presenting to the ED with acute scrotum are referred immediately to the ultrasound unit, and scrotal DUS examinations are performed without delay. When testicular torsion is clinically suspected, the on-call urologist is usually present during the DUS examination to view the images online with the radiologist. Thus, in our experience, scrotal DUS performed on a 24-hours basis for the assessment of patients presenting with acute scrotum proved to be a reliable preoperative imaging modality. Doppler ultrasonography has also been shown to decrease the number of emergency surgical explorations and the length

Figure 2. Acute myeloid leukemia spread to the testis. **A**, Gray scale transverse sonogram showing an enlarged hypoechoic testis. **B**, Color Doppler image showing increased vascularity in the testis. **C**, Cut sections through the testis showing homogeneous tissue. **D**, Histopathologic sample of the surgically removed testis showing testicular tissue infiltrated by AML cells (hematoxylin-eosin, original magnification ×50).



of hospital stays[11] and to provide medicolegal support in cases in which surgical exploration is excluded.[14] However, DUS should only be performed as long as there is no delay to surgical exploration. Because the information it can provide is operator dependent, and overlaps exist between the different entities, the diagnosis of torsion has to be supported by a relevant clinical history and physical examination of the patient, or a differential diagnosis must be suggested (eg, acute epididymo-orchitis). With an NPV of 98%, DUS can very efficiently exclude the diagnosis of torsion. However, it should be emphasized that the clinical history and signs play important roles in the decision of whether and how urgently the patient should be taken for surgical exploration.

The presentation of testicular malignancy with acute pain is rare and not routinely imaged emergently. About 15% of such cases are detected incidentally when emergent scrotal ultrasonography is performed.[15] When detected, intratesticular lesions are more likely to be malignant and should be considered as such until proven otherwise.[16] With an NPV of 98%, the diagnosis of intratesticular malignancy can be efficiently ruled out by DUS. There are a variety of benign intratesticular processes, such as hematoma, focal orchitis, abscesses, infarction, and granuloma, which may mimic testicular malignancy and must therefore be considered in the differential diagnosis.[17]

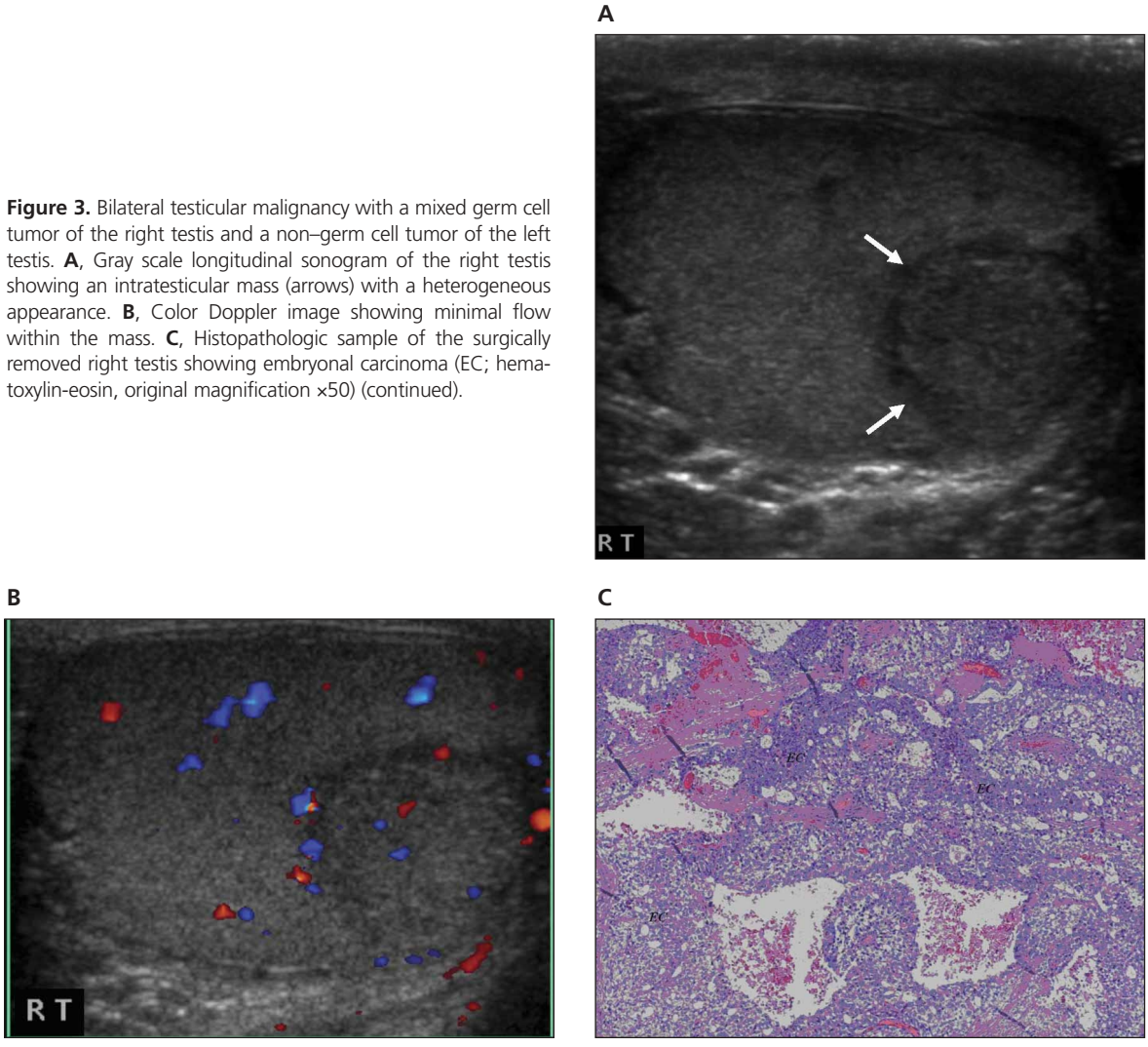
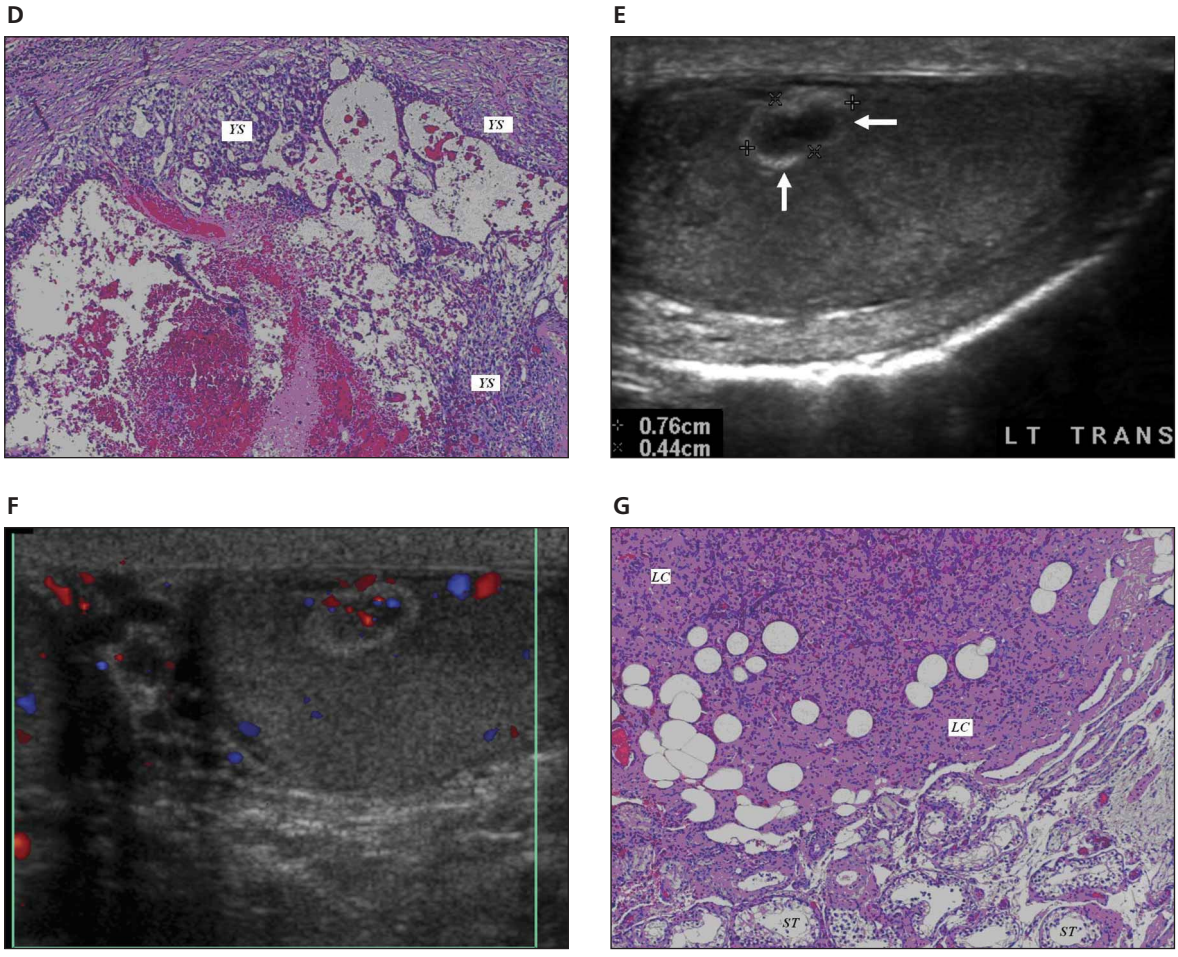


Figure 3. Bilateral testicular malignancy with a mixed germ cell tumor of the right testis and a non–germ cell tumor of the left testis. **A**, Gray scale longitudinal sonogram of the right testis showing an intratesticular mass (arrows) with a heterogeneous appearance. **B**, Color Doppler image showing minimal flow within the mass. **C**, Histopathologic sample of the surgically removed right testis showing embryonal carcinoma (EC; hematoxylin-eosin, original magnification ×50) (continued).

Age is known to be a predictive factor for the likelihood of testicular malignancy. Intratesticular malignancy is most common in patients aged 15 to 34 years; seminoma, the most common type of testicular tumor, has a peak incidence at 35 to 39 years.[16] The mean age of patients with testicular malignancy in our study was considerably higher than that of patients without testicular malignancy (38 versus 21 years). The most common type of malignancy found was a mixed germ cell tumor (5 patients); seminoma was found in only 2 patients, who were 36 and 37 years old.

Testicular and paratesticular metastases are uncommon and often occur in patients with known malignancy at an advanced stage. The most common primary sources are the prostate, lungs, melanoma, colon, and kidneys.[17] Metastatic spread was found in 3 patients in our study population: 1 with metastatic spread of mucinous adenocarcinoma of the colon (stage IIIB) to the testicular cord and tunica albuginea and 2 with secondary spread of acute myeloid leukemia (AML) to the testis. Interestingly, 1 of the patients with AML spread to the testis was known to be in remission at the time testicular involvement was diagnosed. Testicular relapse of AML is uncommon in the absence of systemic disease, with only 17 cases previously reported in the literature, and evidence shows that it predicts widespread, perhaps occult, systemic disease.[18]

Figure 3. (continued) **D**, Histopathologic sample showing a yolk sac (YS) component and mixed germ cell tumor (hematoxylin-eosin, original magnification ×50). **E**, Gray scale transverse sonogram of the left testis showing a hypoechoic intratesticular mass (arrows) with an echogenic rim. **F**, Color Doppler image showing flow within the mass. **G**, Histopathologic sample of the surgically removed left testis showing a Leydig cell non–germ cell tumor (LC; hematoxylin-eosin, original magnification ×50).



Traumatic acute scrotum is more commonly due to blunt scrotal trauma.[19] The current standard management of testicular injuries includes early surgical intervention, specifically in cases of testicular rupture and tunica albuginea disruption, to achieve a higher testicular salvage rate.[8] Ultrasonography helps identify cases that require immediate exploration when the clinical examination is inconclusive. Doppler ultrasonography has been shown to have 71% to 100% sensitivity and 77% to 80% specificity for testicular traumatic injury.[8,20,21] In our study, among the 8 patients who underwent surgical exploration with DUS findings suggestive of large testicular hematoma, the diagnostic performance of DUS was higher than previously reported, with a 100% NPV.

It is well understood that primary testicular tumors are vascular lesions, whereas hematoma is nonvascular. Furthermore, a relevant clinical history (previous trauma) for the presence of hematoma should also help delineate between the two entities. However, 15% of testicular tumors first present after scrotal trauma,[21] and hemorrhage from an underlying tumor may cause a false-positive diagnosis of testicular rupture and hematoma. In our study, among the 3 patients who underwent surgical exploration with a DUS differential diagnosis of testicular hematoma and malignancy, the histopathologic diagnosis was malignancy in 1 case.

Our study was limited by a variety of factors, primarily its retrospective nature and selection bias. First, our medical institution is the single level I trauma center in the northern region of the country, with the highest number of ED visits[22]; thus, the complexity and case variety may have been slightly skewed and might not have been generalized to smaller rural medical institutions.

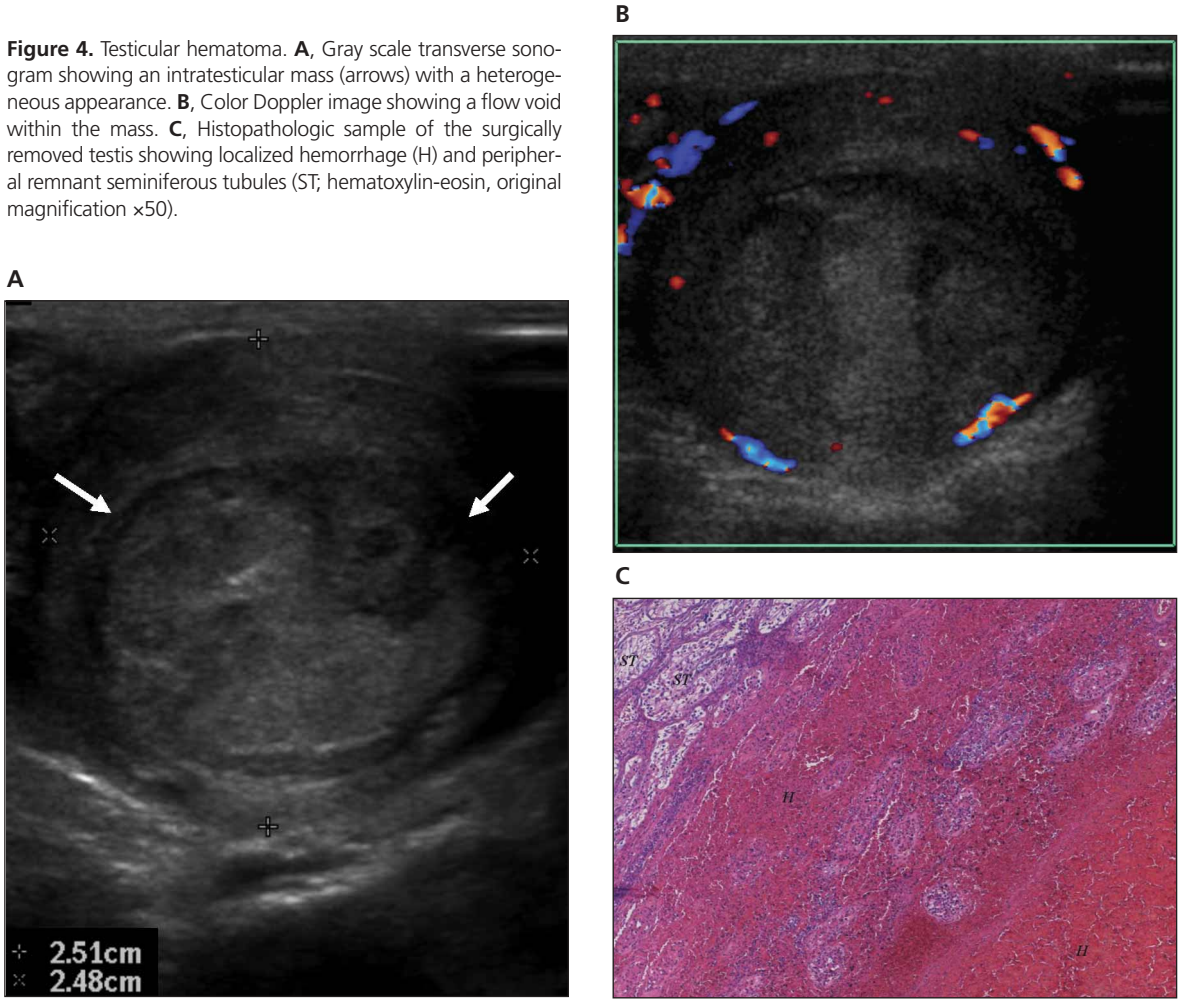


Figure 4. Testicular hematoma. **A**, Gray scale transverse sonogram showing an intratesticular mass (arrows) with a heterogeneous appearance. **B**, Color Doppler image showing a flow void within the mass. **C**, Histopathologic sample of the surgically removed testis showing localized hemorrhage (H) and peripheral remnant seminiferous tubules (ST; hematoxylin-eosin, original magnification ×50).

Second, we had no data on ED visits or hospitalization at other medical institutions for our population during the study period. Moreover, clinical follow-up was unavailable for patients discharged from the ED who did not return at a later time; thus, we had no data regarding the performance of DUS in this subgroup of patients.

In summary, acute scrotum is a diagnostic dilemma. The use of rapid scrotal DUS at the point of care can be useful in the ED. The high diagnostic performance, especially the high NPVs for testicular torsion, malignancy, and hematoma, validates routine use of DUS as a preoperative diagnostic tool in the initial triage of patients with acute scrotum presenting to the ED.

References

1. Aso C, Enríquez G, Fité M, et al. Gray-scale and color Doppler sonography of scrotal disorders in children: an update. Radiographics 2005; 25:1197–1214.
2. Burgher SW. Acute scrotal pain. Emerg Med Clin North Am 1998; 16:781–809.
3. Hamm B. Differential diagnosis of scrotal masses by ultrasound. Eur Radiol 1997; 7:668–679.
4. Vijayaraghavan SB. Sonographic differential diagnosis of acute scrotum: real-time whirlpool sign, a key sign of torsion. J Ultrasound Med 2006; 25:563–574.
5. Schalamon J, Ainoedhofer H, Schleef J, Singer G, Haxhija EQ, Höllwarth ME. Management of acute scrotum in children: the impact of Doppler ultrasound. J Pediatr Surg 2006; 41:1377–1380.
6. Blaivas M, Sierzenski P, Lambert M. Emergency evaluation of patients presenting with acute scrotum using bedside ultrasonography. Acad Emerg Med 2001; 8:90–93.
7. Cavusoglu YH, Karaman A, Karaman I, et al. Acute scrotum: etiology and management. Indian J Pediatr 2005; 72:201–203.
8. Buckley JC, McAninch JW. Use of ultrasonography for the diagnosis of testicular injuries in blunt scrotal trauma. J Urol 2006; 175:175–178.
9. Dell'Atti L, Fabiani A, Marconi A, Mantovani P, Muzzoniqro G. Reliability of echo-color-Doppler in differential diagnosis of the "acute scrotum": our experience. Arch Ital Urol Androl 2005; 77:66–68.
10. Zini L, Mouton D, Leroy X, et al. Should scrotal ultrasound be discouraged in cases of suspected spermatic cord torsion [in French]? Prog Urol 2003; 13:440–444.
11. Lam WW, Yap TL, Jacobsen AS, Teo HJ. Colour Doppler ultrasonography replacing surgical exploration for acute scrotum: myth or reality? Pediatr Radiol 2005; 35:597–600.
12. Abul F, Al-Sayer H, Arun N. The acute scrotum: a review of 40 cases. Med Princ Pract 2005; 14:177–181.
13. Burks DD, Markey BJ, Burkhard TK, Balsara ZN, Haluszka MM, Canning DA. Suspected testicular torsion and ischemia: evaluation with color Doppler sonography. Radiology 1990; 175:815–821.
14. 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; 60:120–124.
15. Wittenberg AF, Tobias T, Rzeszotarski M, Minotti AJ. Sonography of the acute scrotum: the four T's of testicular imaging. Curr Probl Diagn Radiol 2006; 35:12–21.
16. Passarella M, Usta MF, Bivalacqua TJ, Hellstrom WJG, Davis R. Testicular-sparing surgery: a reasonable option in selected patients with testicular lesions. BJU Int 2003; 91:337–340.
17. Dogra VS, Gottlieb RH, Oka M, Rubens DJ. Sonography of the scrotum. Radiology 2003; 227:18–36.
18. Shaffer DW, Burris HA, O'Rourke TJ. Testicular relapse in adult acute myelogenous leukemia. Cancer 1992; 70: 1541–1544.
19. Deurdulian C, Mittelstaedt CA, Chong WK, Fielding JR. US of acute scrotal Trauma: optimal technique, imaging findings, and management. Radiographics 2007; 27:357–369.
20. Guichard G, El Ammari J, Del Coro C, et al. Accuracy of ultrasonography in diagnosis of testicular rupture after blunt scrotal trauma. Urology 2008; 71:52–56.
21. Dogra VS. Testicle, trauma. emedicine website. http://www. emedicine.com/radio/topic682.htm. Updated December 21, 2006. Accessed September 13, 2008.
22. Israel Ministry of Health. Statistical data: emergency department visits, 2003–2006. Israel Ministry of Health website. http://www.health.gov.il/Download/pages/4.pdf.