Radionuclide Scrotal Imaging: Further Experience with 210 New Patients Part 2: Results and Discussion

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RESULTS

Acute scrotal pain. The final diagnoses of 109 patients presenting with acute scrotal pain are shown in Table 1. Those who had acute pain but whose complaints were directly related to trauma are listed separately in Table 5. Sixty-nine patients had acute scrotal inflammation that responded to antibiotic treatment. Despite imaging diagnosis of inflammation, three patients were operated on because the clinician strongly suspected torsion. The pathologic results confirmed acute inflammation in the epididymis, with torsion absent. Forty-five patients had acute epididymitis. In 32 of these the RNA pattern consisted of increased perfusion through the vessels of the spermatic cord and to the lateral aspect of the hemiscrotum, corresponding to the usual location of the epididymis. The scrotal study revealed linear or curvilinear increased tracer activity to the head, body, and tail of the epididymis (Fig. 11, upper). Displacement of the epididymis centrally or even medially was noted in 13 of these 45 patients (Fig. 11, lower). Five patients had acute epididymo-orchitis. Their RNAs showed increased perfusion through the cord vessels, and not only to the epididymis but also extending medially to the inflamed testicle. The scrotal image revealed asymmetric increased activity extending from the epididymis to the testicle (Fig. 12).

Nineteen patients had acute focal epididymitis. Clinically these patients had less severe pain, less swelling, and more focal tenderness. The diagnosis is confirmed by the scan findings. In the RNAs of a majority of these patients (n = 12), there was not enough blood flow through spermatic cord or extra-cord vessels to define them. Mild, increased perfusion was noted in seven patients (four only in the cord vessels and three in both cord and extra-cord vessels). Scrotal perfusion in 17 patients showed a small area of increased focal activity that corresponded to the inflamed portion of the epididymis. In two patients the RNAs showed no increased scrotal perfusion. The scrotal image was abnormal in all 19 patients, demonstrating a focal area of tracer accumulation corresponding to the anatomical location of the head (n = 9), body (n = 6), or tail (n = 4) of the epididymis (Fig. 13).

Thirty-five patients had acute torsion. Surgical exploration was performed on all but four, with torsion confirmed. Two patients refused surgical exploration; one was not operated on because the clinician judged the testicle to be nonviable; and another was treated with antibiotics because of the primary physician's unshakable conviction of infection. Each of these four patients had testicular atrophy in their long-term follow-up.

Table 2 summarizes the scintigraphic characteristics of different phases of testicular torsion (Figs. 14–17). These characteristics relate to the changes described in the section on pathophysiology. In nine cases a "nubbin sign" was noted in the RNA. We have suggested this term to describe a "nubbin" or bump of activity extending medially from the iliac artery (Figs. 15, 16). It may be due to the reactive increased blood flow in the spermatic cord vessels, terminating abruptly at the site of the twist (*3*).

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TABLE 1. FINAL DIAGNOSIS OF PATIENTS WITH ACUTE SCROTAL PAIN*

Final diagnosis	No. patients	Pathologic confirmation	Correct image diagnosis
Acute inflammation	69		
Acute epididymitis	45	2	45
Acute epididymo-orchitis	5	0	5
Focal epididymitis	19	1	19
Acute testicular torsion	35		
Resolved torsion	1	1	1
Early phase (0–7 hr)	13	13	13
Middle phase (7–24 hr)	5	5	5
Late phase (more than 24 hr)†	16	12	16
Torsion of appendix testis	1	1	0
Normal	4	1	4
Total	109	35	108

* Patients whose complaints were directly related to trauma are not included in this group.

† Three of these patients were imaged more than 5 days after initial symptoms of acute pain. They were included here for completeness in describing the spectrum of testicular torsion.

When the radionuclide examination demonstrated an early (n = 13) or middle (n = 5) phase of testicular torsion (Figs. 14, 15), surgery was performed immediatly and all the patients' twisted testicles were salvaged. A "missed torsion" (late phase of torsion) pattern was observed in 16 patients (Fig. 16), and here only two testicles were salvaged. One was in a 29-yr-old man who presented with acute scrotal pain, beginning three days before examination. At the time of operation, his left cord was twisted three complete turns and the testicle was black. The surgeon relieved the twist and put warm gauze on the testicle. About 5 min later this testicle turned pink, orchiopexy was performed, and follow-up RSI demonstrated a well-perfused testicle. The second salvaged testicle was in a 27-yr-old who presented with a 28-hr history of sudden scrotal pain and an enlarged left testicle. At surgery the testicle was purplish blue, but not hemorrhagic or necrotic. The spermatic cord had twisted only 180°. Bilateral orchiopexy was then performed.

Manual untwisting was performed on one patient before radionuclide imaging, which proved normal. Orchiopexy was performed the same day, and at surgery his right testis was slightly bluish. The spermatic cord was long but not twisted.

Four patients with acute scrotal pain had normal studies. Surgery on one of these patients revealed a normal testicle with no evidence of testicular torsion. The other three were followed clinically and did well without subsequent genital problems. One patient had torsion of an appendix testis. RSI showed a poorly perfused right testicle. Under the impression of early torsion, surgery was performed; a small hydrocele and torsion of a cyst of Morgagni were found; the testicle was normal. This is a case of a false-positive diagnosis of acute testicular torsion.

Subacute scrotal pain. Table 3 lists the final diagnoses of 25 patients with subacute scrotal pain. In ten of them, the diagnosis was nonacute epididymitis. Two of these had pathologic diagnosis. This group included two patients who were previously treated for acute epididymitis with incomplete or slow resolution, and eight patients who had mild focal epididymitis and did not seek treatment when symptoms originally began. In seven of these ten, their RNAs showed no increased flow in either the testicular or pudendal arteries. Three of them did have mild increased perfusion in the testicular arteries. Mildly increased scrotal perfusion was noted in all patients except one, whose scrotal perfusion was normal. In the scrotal study, mildly or moderately increased activity was noted in the entire epididymis (n = 3), head (n = 1), body (n = 4), or tail (n = 2). The scrotal imaging pattern of nonacute epididymitis is indistinguishable from acute focal epididymitis.

Four patients had scrotal abscess. All originally presented with symptoms of acute epididymitis and were treated with antibiotics. When their symptoms did not improve, however, they were referred for RSI to separate slowly resolving epididymitis or scrotal abscess from missed torsion. In their RNAs, profoundly increased tracer activity was noted, not only in the vessels passing through the spermatic cord but also in the pudendal artery. Scrotal perfusion was also markedly increased, with activity present in the dartos and the hemiscrotum (Fig. 18). In the scrotal study, markedly increased tracer activity was seen throughout the hemiscrotum, with an area of decreased activity representing the abscess. These four patients were explored and the abscesses were drained.

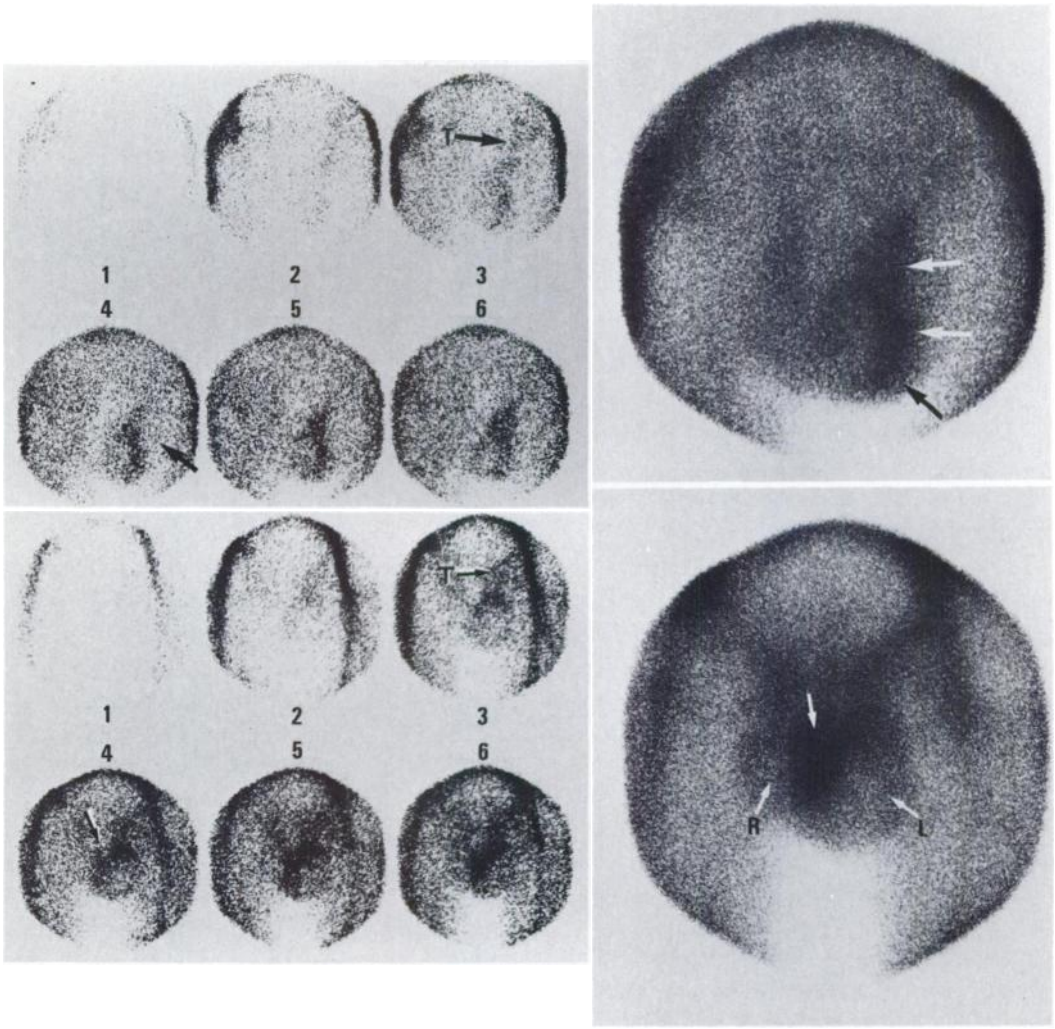

FIG. 11. Acute epididymitis. RNA (upper left): Note activity in testicular and deferential vessels (T) and gently curved scrotal perfusion located in expected lateral position of epididymis (arrows). (1) 0–5 sec, (2) 6–10, (3) 11–15, (4) 16–20, (5) 21–25, (6) 26–30. Scrotal image (upper right): Laterally placed, curvilinear density (arrow). RNA (lower left: Activity in the testicular and deferential vessels (T) and curvilinear scrotal perfusion to medially displaced epididymis (arrow). Time intervals as in upper left. Scrotal image (lower right): Medially located epididymis (arrow) that is slightly broader than the average; right (R) and left (L) testicles are normal.

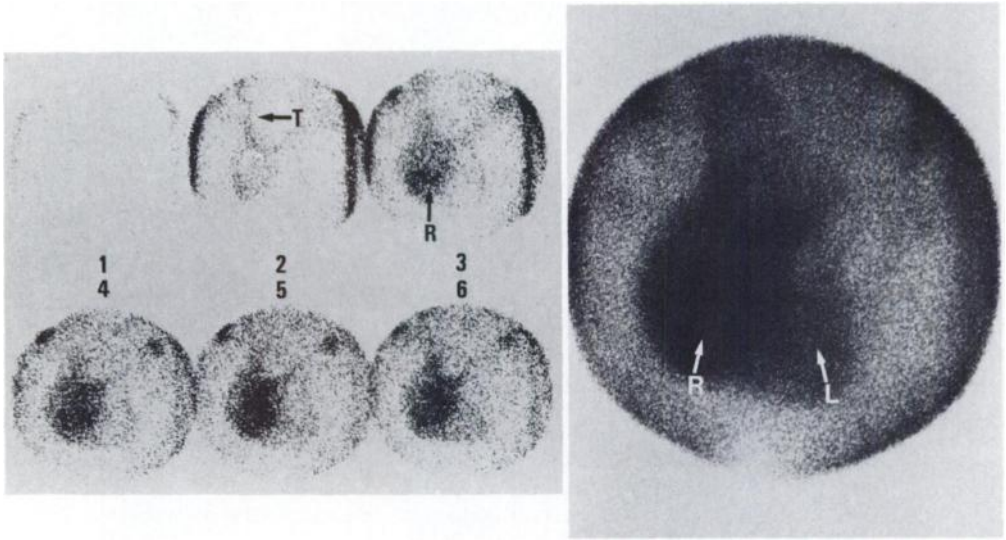

FIG. 12. Epididymo-orchitis. RNA (left): Increased perfusion through testicular and deferential vessels (T). Scrotal perfusion, directed laterally, but curved less obviously in this case, broadens to include right testicle (R). Timing as in Fig. 11. Scrotal image (right): Increased activity involving right testicle (R). Normal left testicle (L).

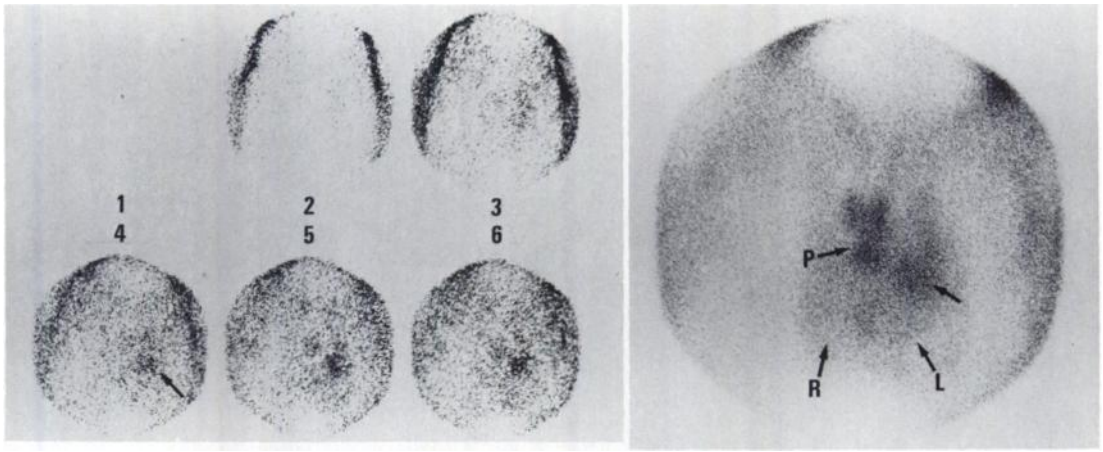

FIG. 13. Focal epididymitis. RNA (left): No increased perfusion of testicular or deferential vessels. Area of focal increased scrotal perfusion is seen (arrow). Timing as in Fig. 11. Scrotal scan (right): Focal area of increased activity corresponds to head of epididymis (arrow). Right (R) and left (L) testicles are normal. Activity at base of penis (P) is normal.

Ten patients with subacute scrotal pain had normal RSI. Three had emotional or psychosomatic problems. Four patients complained of mild, intermittent scrotal pain after a vasectomy, varicocelectomy, or orchiopexy. Three had chronic intermittent scrotal pain or mild swelling without any clinical symptoms or signs of epididymitis. Because of normal RSI, they were treated conservatively and did not develop any problems. One patient was found to have a simple hydrocele without image evidence of inflammation. He did well without treatment.

Scrotal mass. In 56 patients the chief complaint was a scrotal mass; 11 had some pain and 46 were pain-free. The final diagnoses of these patients are shown in Table 4. There were nine tumors, all surgically proved. These included four seminomas, two embryonal carcinomas, two granulomas, and one gumma.

In seminoma, the RNA showed increased perfusion through the testicular artery (n = 3), or occasionally through the pudendal (n = 2). No increased perfusion through the vessels was noted in one patient. Increased scrotal perfusion was directed centrally to the hemiscrotum rather than laterally or medially toward the epididymis (Fig. 19). Scrotal perfusion was diffusely (n = 3) or focally (n = 1) increased in the involved hemiscrotum. Increased activity was seen in all seminomas in the scrotal image; in three patients it was diffusely homogeneous and in one it was focal.

TABLE 2. FIVE PHASES OF TESTICULAR TORSION

Scan:	Spontaneous or manual untwisting (0–4 hr)	Early phase (0–7 hr) (Fig. 14)	Middle phase (7–24 hr) (Fig. 15)	Late phase (1–30 days) (Fig. 16)	Atrophy phase (more than 2 yr)† (Fig. 17)
Radionuclide angiogram					
Cord vessels	NL*	NL or Nubbin sign	Nubbin sign or NL	Nubbin sign or NL	NL
Extracord vessels	NL	NL	NL or min inc	Min to mod inc	NL
Scrotal perfusion	NL	NL	Mild inc to dartos	Mod inc to dartos	NL
Scrotal scan	NL or mild hyperemia‡	Asymmetric; min dec in testicle	Min dec in the center; mod inc dartos "halo-like"	Min-mod dec in the center; marked inc dartos "halo-like"	Asymmetric; min dec in testicle; small hemiscrotum
Clinical symptom	Acute scrotal pain	Acute scrotal pain	Acute scrotal pain with mass	Acute scrotal pain with mass	No pain with small testicle

* NL = normal; inc = increased activity; dec = decreased activity; min = minimal; mod = moderate.

† No cases between 1 mo and 2 yr after clinical presentation of acute scrotal pain.

‡ Reported previously, Ref. 2.

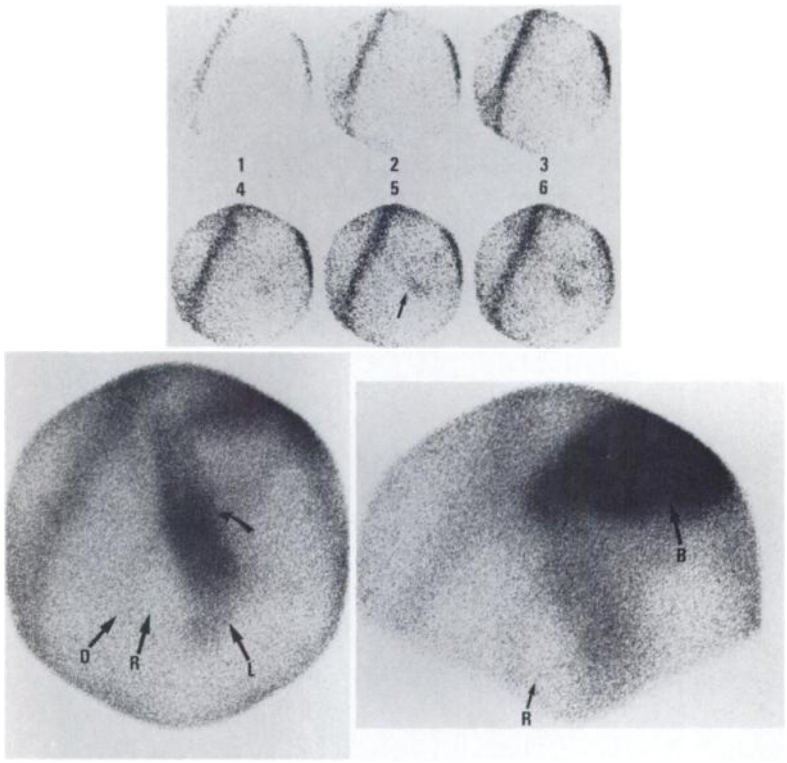

FIG. 14. Early testicular torsion. RNA (upper): No flow through testicular or deferential vessels. Minimal scrotal perfusion is seen at base of penis on later frames (arrow). Timing as in Fig. 11. Scrotal scan (lower left): "−2" avascular right testicle (R) (see text for grading scales). No increased activity ("0") in dartos (D). Left testicle (L) is normal. Marked increased activity in penis (curved arrow), occasionally seen, has no diagnostic significance. Lead-shielded image (lower right): Avascular right testicle (R) is accentuated. Penile activity is less clear on this image, which was taken immediately after preceding. Bladder (B) shows excreted pertechnetate. Testicle was salvaged.

In both embryonal carcinomas there was increased perfusion through the testicular artery. Scrotal perfusion to the involved hemiscrotum was increased diffusely in one patient and focally in the other. Heterogeneous tracer distribution (both increased and decreased areas of activity) was noted in the scrotal studies of both patients.

In both patients with granuloma, the RNA showed increased perfusion through the testicular artery and focally increased perfusion to the scrotum. On the scrotal image, the granulomas appeared as hypovascular. In one patient the granuloma was multicystic.

One patient had gumma in his left testicle. His RNA showed increased perfusion through the testicular and

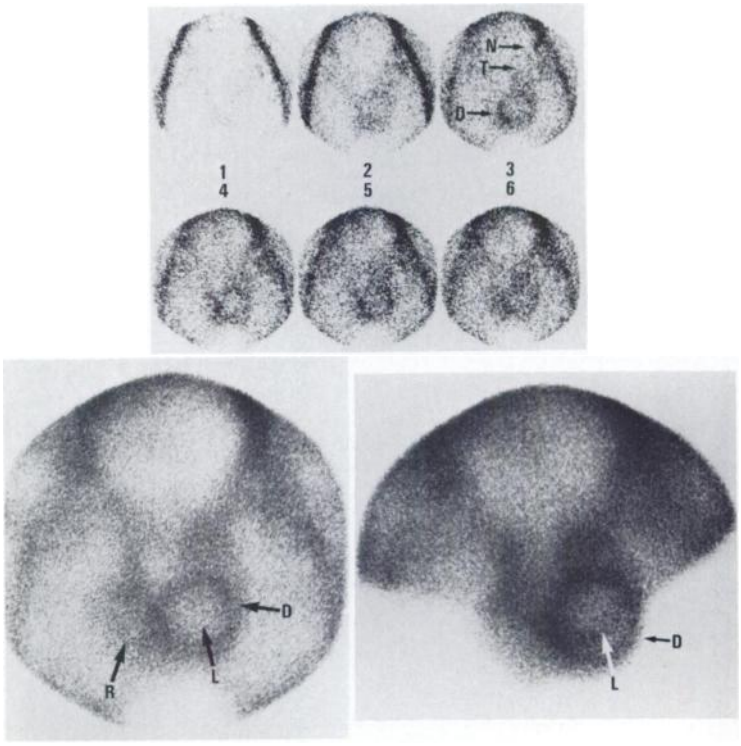

FIG. 15. Midphase testicular torsion. RNA (upper): Obvious nubbin sign (N), no increased perfusion through testicular or deferential vessels (T), and halo-like increased dartos perfusion (D) are all seen. Timing as in Fig. 11. Scrotal image (lower left): "+2" increased dartos activity (D). "−2" decreased activity in slightly enlarged left testicle (L). (See text for grading.) Normal right testicle (R). Lead-shielded image (lower right): Dartos activity (D) is less prominent, and left-testicular avascularity (L) seems less. Testicle was salvaged.

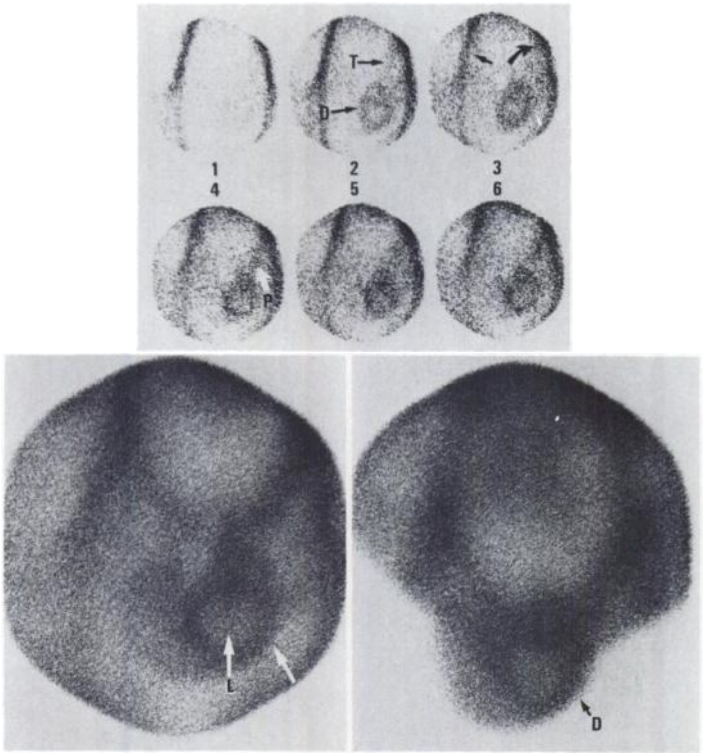

FIG. 16. Late-phase testicular torsion. RNA (upper): There is no increased perfusion through testicular or deferential vessels (T), whereas during same arterial-phase frames halo-like increased perfusion is seen in dartos (D). Smooth border of right iliac/femoral arteries (straight arrow) contrasts with thickening on left (curved arrow), which represents subtle nubbin sign. Some suggestion of pudendal artery (P). Timing as in Fig. 11. Scrotal image (lower left): "+2" increased dartos activity (arrow) and "−1" decreased left testicular activity (L). (See text for grading scale.) Lead-shielded image (lower right): in this case, it is not significantly different from unshielded scrotal scan shown at left, although dartos activity (D) is accentuated. Testicle infarcted.

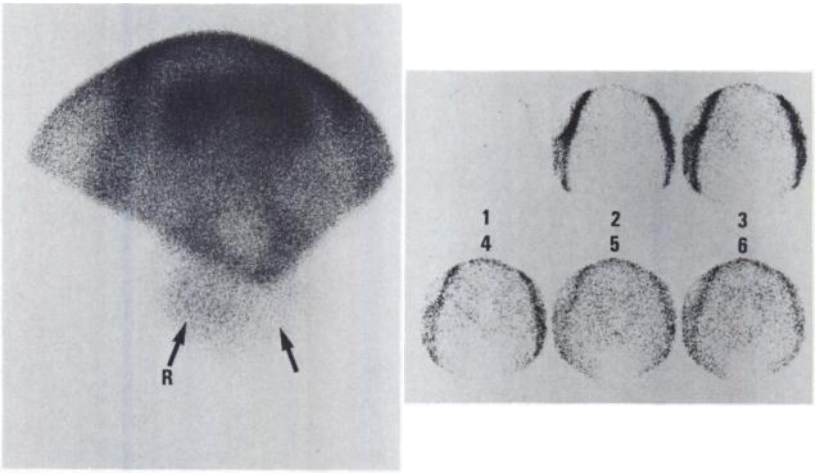

FIG. 17. Scrotal image (left): lead-shielded image. Normal right testicle (R). Left hemiscrotum is smaller, with minimal overall activity (arrow). No sign of small left testicle. Testicular atrophy. RNA (right): No increased perfusion through cord or extracord vessels. Scrotal perfusion is normal, without any delineation of smaller left hemiscrotum and small left testicle. Timing as in Fig. 11.

TABLE 3. FINAL DIAGNOSIS OF PATIENTS WITH SUBACUTE SCROTAL PAIN*

Final diagnosis	No. Patients	Pathologic confirmation	Correct image diagnosis
Abscess	4	4	4
Nonacute epididymitis	10	2	10
Hydrocele	1	0	1
Normal	10	0	10
Total	25	6	25

* Three patients who presented between six and 14 days after an acute episode had missed torsion and were included in Table 1.

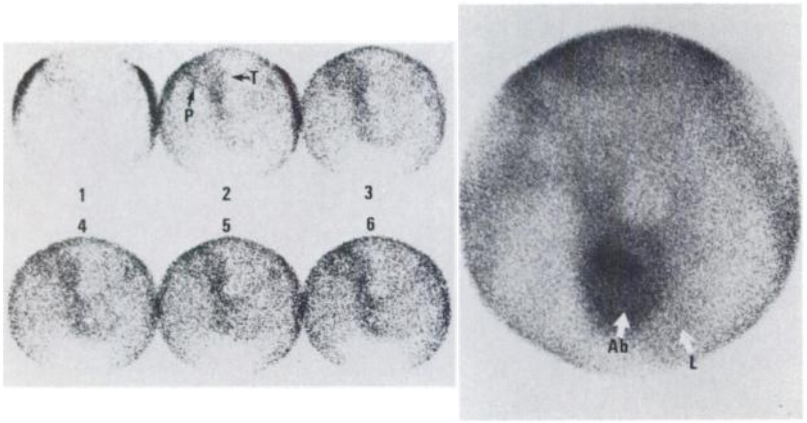

FIG. 18. Abscess. RNA (left): Activity in testicular or deferential vessels (T) and also pudendal artery (P). Scrotal perfusion was increased. Timing as in Fig. 11. Scrotal image (right): Diffusely increased activity throughout the right hemiscrotum, with eccentrically placed area of relatively decreased activity (Ab), similar in size to normal left testicle (L). RNA is needed to make diagnosis of abscess. Surgical confirmation.

pudendal arteries and focally increased perfusion surrounding the photopenic testicle, which was infiltrated with gumma. The scrotal image also showed areas of increased activity surrounding the testicle with diminished activity.

Hydroceles were found in 15 patients, and hydrocelectomies were performed on six. All these patients had the scintigraphic appearance of uncomplicated hydroceles, which will be discussed in the section on hydroceles. Three patients had a spermatocele, a retention cyst of small tubules within the epididymis, usually occurring in the head. The RNA was normal. The scrotal image showed a lucent area corresponding to the location of the spermatocele. Varicocele was diagnosed in three patients. In one the RNA showed increased perfusion in the late (venous) phase (Fig. 20). The scrotal image showed increased tracer activity in the area of the varicocele, with some inferior extension. A normal RNA was noted in the second patient, whose scrotal study showed a focal area of increased tracer. The third had a normal RSI.

Five patients were diagnosed as having chronic epididymitis, with surgical exploration of one. The RNAs of four were normal; the fifth showed focally increased scrotal perfusion. In all five scrotal images, focal increase of activity, mild to moderate, was seen over the epididymis.

Four patients had inguinal hernia. All their RNAs were normal. In two patients the scrotal image showed a lucent area corresponding to the location of a herniated bowel (Fig. 21); the other two scrotal studies were normal.

Two patients had suture granulomas measuring 0.5–1.0 cm in diameter, subsequently removed. The RNAs and scrotal images were normal.

RNA was normal in one surgically confirmed hematoma and in two benign cysts. In all three the scrotal

TABLE 4. FINAL DIAGNOSIS OF PATIENTS WITH SCROTAL MASS

Final diagnosis	No. patients	Pathological confirmation	Correct image diagnosis
Tumor	9	9	5/4*
Hydrocele	15	6	15
Spermatocele	3	0	3
Varicocele	3	3	2
Chronic epididymitis	5	0	5
Inguinal hernia	4	0	2
Suture granuloma	2	2	0
Hematoma	1	1	1
Benign cyst	2	2	2
Others	12†	2	12
Total	56	25	47/4

* In these four patients the image was abnormal, directing further evaluation, but a specific diagnosis was not made.

† Patients in this group were referred to evaluate an asymmetric epididymis (n = 4), postoperative nodule (n = 1), or to obtain objective evidence that a slightly asymmetric testicle was normal (n = 7). All of these patients had normal images and no further workup was done. They were followed for 1–2 yr and no disease was found.

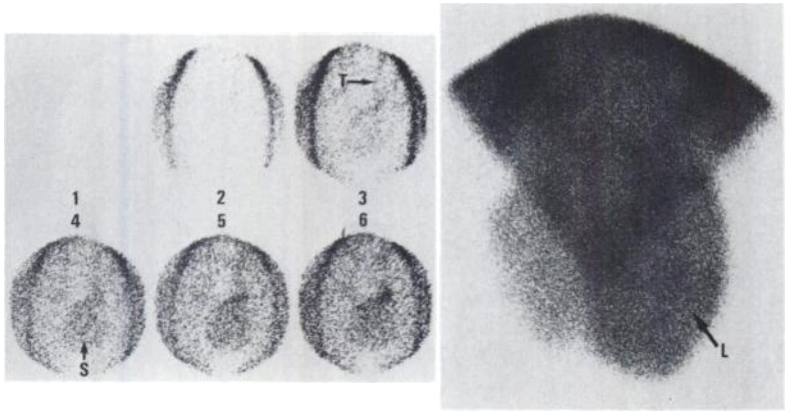

FIG. 19. Seminoma. RNA (left): Increased perfusion through testicular and deferential vessels (T) is directed centrally. Scrotal perfusion (arrow) is diffuse, with no suggestion of curved distribution. Timing as in Fig. 11. Scrotal image (right): Lead-shielded image. Left hemiscrotum (L) is enlarged, with diffuse, homogeneous darkening. Surgical confirmation.

image showed a lucent area in the hemiscrotum without any associated increased activity.

Twelve other patients had normal RNAs and scrotal images. They were scanned to evaluate an enlarged head or tail of the epididymis (n = 4), a small granular nodule that developed after hernioplasty (n = 1), or to rule out an organic testicular mass after a parent or the patient felt one testicle larger than other (n = 7). In the last group, the referring clinicians wanted objective evidence to confirm their impression of normal variation.

Trauma. Seventeen patients had a history of scrotal trauma secondary to the following insults: gunshot wound, knife wound, motorcycle or car accident, blow from a ball, book, foot, or hand; one followed a cardiac arteriogram using the Seldinger technique through the femoral artery. The primary final diagnoses are shown in Table 5.

Three patients had intratesticular hematoma and five had hematocele/hydrocele. In their RNAs, normal or mildly increased perfusion through the testicular or pudendal arteries was noted. In seven of the eight patients, the scrotal image demonstrated an eccentric lucent area in the hemiscrotum: "half-moon" shaped in three of the five hematocele/hydrocele scans, "full-moon" shaped in the fourth, and "flask-shaped" in the fifth. In two of the three intratesticular hematomas, the lucency was small, irregular in shape, and more centrally located within the hemiscrotum (Fig. 22). One intratesticular hematoma was not visualized. Two patients with hematocele/hydrocele also had acute epididymitis.

Four patients had traumatic epididymitis. Their RNAs and scrotal images suggested acute epididymitis in one, and acute focal epididymitis in three.

A bullet had passed through the right hemiscrotum of one patient. The RNA showed moderately increased perfusion through the testicular and pudendal arteries. The scrotal image showed markedly increased activity in the areas injured by the bullet. One patient had a knife injury to his right hemiscrotum. His first RSI examination showed hematocele and scrotal inflammation. Three weeks later, a repeat RNA demonstrated mildly increased perfusion through both the testicular and extra-cord vessels (Fig. 20, upper). The scrotal study showed a small lucency within the right testicle (Fig. 20, center), and an abscess was drained.

One patient had mild trauma and mild pain. His RNA showed no increased perfusion through the testicular and deferential vessels, but mild increased activity was seen in the hemiscrotum. The scrotal image in this case showed mild, diffusely increased activity in the hemiscrotum, no photopenic lesions.

Two patients had histories of trauma and mild pain, but their RNAs and scrotal scans were normal.

Other. Two patients had histories of testicular torsion occurring over 2 yr before being referred to us. Physical examination revealed small testicles without local tenderness. The purpose of RSI was to confirm the clinical

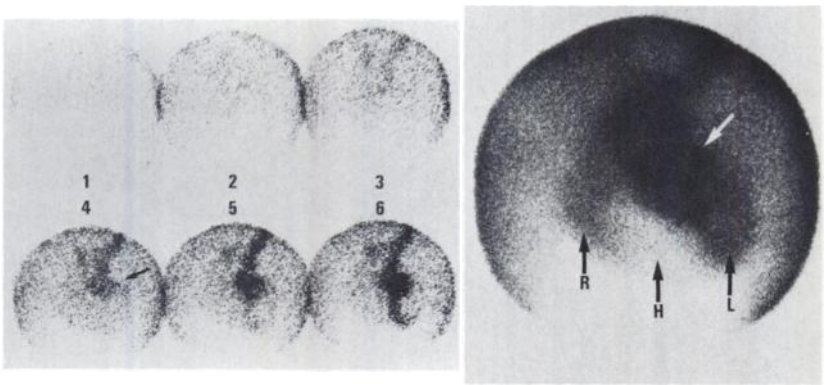

FIG. 20. Varicocele. RNA (left): Increased perfusion becomes obvious in venous phase, with focal increased tracer (arrow) supero-medial to testicle. Timing as in Fig. 11. Scrotal image (right): Increased tracer (arrow) above normal left testicle (L). Normal right testicle (R). Hydrocele (H) is present. Surgical confirmation.

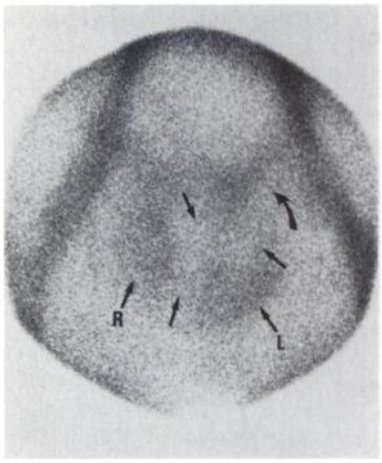

FIG. 21. Inguinal hernia. (The RNA, not shown, was normal.) Scrotal image shows normal testicles (R & L). Avascular areas in hemiscrotum represent herniated bowel (all arrows). Note extension toward left inguinal region (curved arrow). Surgical confirmation.

impression of testicular atrophy. Their RNAs were normal (Fig. 17, left). The scrotal images showed a photopenic testicle without hyperemia in the dartos (Fig. 17, right).

One patient had the final diagnosis of spermatic cord inflammation (funiculitis). He presented with acute onset of right groin pain radiating to the testicle. The RNA showed no increased perfusion through the cord or extra-cord vessels. The scrotal image showed focally increased activity in the right inguinal canal; no abnormalities were seen in the scrotum.

Hydrocele. Table 6 shows the incidence of hydrocele in our study. Primary hydrocele occurred in 16 patients: 13 with single hydrocele (Fig. 23, far left), two bilateral (Fig. 23, near left), and one accompanying a spermatocele. There were 25 patients with secondary hydrocele. Inflammatory hydrocele occurred in 16 patients with epididymitis—ten acute and six focal (Fig. 23, center).

Four hydroceles were related to trauma. A hydrocele was noted in one patient with acute testicular torsion and in one with a scrotal tumor. Three hydroceles were noted in follow-up images done after orchiopexy.

In primary hydrocele, the RNA demonstrates a normal perfusion pattern. In secondary hydrocele, the appearance reflects the underlying lesion. Both primary and secondary hydroceles gave similar scrotal images. Thirty-three showed a lucency, often "half-moon" shaped, surrounding the testicle (Figs. 23, far left and center). Eight showed a testicle "floating" in a pool of hydrocele fluid (Fig. 23, near right). A lead-shield image is often very helpful in detecting a hydrocele. Imaging in the standing position will often show fluid movement and confirm the diagnosis (Fig. 23, far right).

DISCUSSION

Value and limitations of RSI. The results from this series of patients again confirm that RSI should be considered in all patients with acute scrotal pain. All patients with testicular torsion were so identified, as were all patients with infection. No false negatives were encountered. The one false positive (a torsion of the appendix testis) was diagnosed as a testicular torsion because the additive effect of an associated hydrocele produced a larger area of decreased relative vascularity, which was mistaken for an avascular testicle.

Although none of our patients with testicular torsion was over age 30, 14 (40%) were between 21 and 30. This gives further evidence that although torsion is not a disease of middle age, it is certainly not confined to adolescence, as suggested by other authors (*14*,*25*,*26*). Acute epidiymitis was seen in 14 patients between 11 and

TABLE 5. PRIMARY FINAL DIAGNOSIS OF PATIENTS WITH TRAUMA

Final diagnosis	No. patients	Pathologic confirmation	Correct image diagnosis
Intratesticular hematoma	3	1	2
Hematocele/hydrocele	5*	3	5
Traumatic epididymitis	4	1	4
Focal hyperemia/tissue destruction	1†	1	1
Abscess	1‡	1	1
Hyperemia	1	0	1
Normal	2	0	2
Total	17	6	16

* Two of them also had acute epididymitis.

† This patient had a gunshot wound.

‡ This patient had a knife injury to his right hemiscrotum. His first RSI showed hematocele and scrotal inflammation. Ultrasound at this time suggested concurrent intratesticular lesion. Three weeks later, a repeat RNA demonstratesd an abscess.

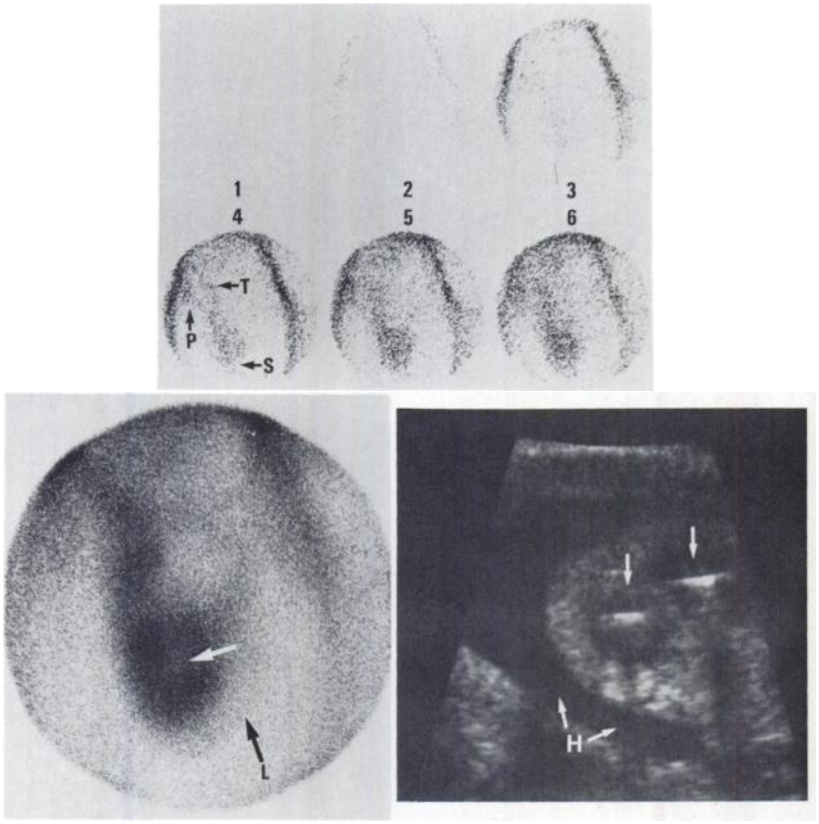

FIG. 22. Trauma, intratesticular hematoma/abscess. RNA (upper): Increased perfusion through testicular and deferential vessels (T) and pudendal artery (P). Scrotal perfusion was diffuse (S). Timing as in Fig. 11. Scrotal image (lower left): Small left hemiscrotum (L) from previous orchiectomy. Right hemiscrotum shows diffuse, increased activity with paler eccentric area (arrow). Sonogram (lower right): longitudinal, done before RSI. Echoes are white against black background. Small hydrocele (H). Adjacent 13-mm and 9-mm intratesticular areas of mixed echogenic pattern (arrows). Surgical confirmation.

20 yr of age, and in one of our three patients less than 10 yr old. These 15 patients (22% of those with infection) and the 17 patients between ages 21 and 30 (25%) confirmed that epididymitis is no longer a condition just affecting the middle-aged man with prostatitis. This increased awareness probably accounts for the growing number of scans we perform and for the fact that 51% of the torsions we encountered were in the early and midphase.

The 56 patients presenting with scrotal enlargement had a variety of lesions. RSI was abnormal in 91% (51 of 56 patients) and a diagnosis was made in 84% (47 of 56). This includes 12 patients with normal scans, two of whom had pathologic confirmation and ten who have been followed for 1–2 yr without the development of any abnormality. Knowing that intratesticular lesions of less than 1–1.5 cm are below the resolution capabilities of our imaging systems, we have begun suggesting that when modern high-resolution ultrasound equipment, with transducer >5 MHz, is available, a confirmatory ultrasonogram should be obtained. This technique theoretically should identify those small avascular lesions not seen by RSI, and thus complement the RSI study. RSI can find small lesions having increased relative vascularity, as was the case with one of our four seminomas. We were unable to diagnose two suture granulomas; at surgery they measured less than 1 cm in diameter. Our experience with varicoceles remains scanty. Although other authors (*28*,*29*) have reported that radionuclide scrotal scanning is sufficient to detect varicoceles, we were unable to define one surgically proven small varicocele. However, the tracers were different: they used Tc-99m-labeled red blood cells, whereas we used pertechnetate.

Two of four inguinal hernias, presenting initially as a mass, did not demonstrate the expected avascular areas. We think this may have been due to the intermittent nature of the hernia, with no bowel herniated at the time of imaging. Other findings in RSI are nonspecific, such as the focal increased perfusion and focal increased activity on the scrotal study in patients with

TABLE 6. INCIDENCE OF HYDROCELE IN 210 PATIENTS

Final diagnosis	No.	patients
Primary hydrocele		16
Single hydrocele	13	
Double hydrocele	2	
With spermatocele	1	
Secondary hydrocele		25
Inflammatory hydrocele	16	
Traumatic hydrocele	4	
With acute torsion	1	
With scrotal tumor	1	
Postorchiopexy	3	
Total		41

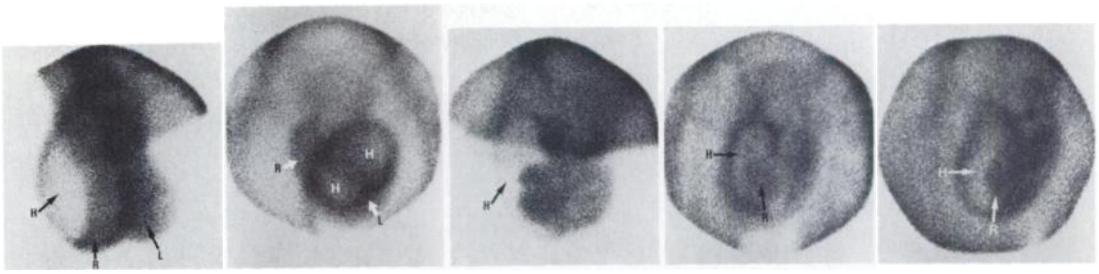

FIG. 23. Hydrocele, scrotal images. Single hydrocele (far left): Lead-shielded image. Half-moon avascular area (H) is most common appearance of hydrocele. Normal testicles (R & L). Double hydrocele (near left): Avascular areas (H) are located inferomedially and superolaterally. Right testicle (R) is more obvious than left (L). Inflammatory hydrocele (center): Lead-shielded image. Half-moon avascular area (H) surrounds swollen, inflamed, tortuous epididymis. Single hydrocele patient supine (near right): Avascular area (H) appears as a pool with testicle (R) floating within it. Same patient, standing (far right): After fluid shifts, avascular area (H) is now half moon. Right testicle (R) has assumed more dependent position.

chronic epididymitis. These results, however, have value when combined with the clinical history, physical examination, and results of other laboratory tests.

Hydroceles are extremely common in all types of scrotal disease. Although 20% of our patients did have hydroceles, the true incidence of hydrocele is probably higher, since small hydroceles are below our level of resolution.

In patients with acute trauma, the radionuclide image reflects the amount of vascular disruption. We were able to identify lesions in 94%. In one patient we described a hematocele/hydrocele on the initial study and an intratesticular abscess on the follow-up study. Concurrent ultrasound examinations suggested that a small 13-mm intratesticular lesion was probably present at the time of the first study.

In two patients whose only posttrauma symptom was mild pain, we believe the cause was contusion of the testis. The testicular capsule is particularly sensitive to direct force or even mild pressure from intratesticular edema. Often lesions of this type are just too small to resolve. In injury cases the scan has value in providing a baseline study and in assessing the perfusion to, and relative vascularity of, the scrotum and its contents. If after injury the scrotum is abnormal to palpation, and RSI does not provide a compatible diagnosis, an ultrasound test is suggested. We have not examined enough patients with lesions of the spermatic cord to make any significant observations.

The significance of a normal radionuclide scrotal imaging examination in patients with acute scrotal pain. Because of the grave consequence of failure to diagnose testicular torsion, we established the principle that a "normal radionuclide scrotal imaging examination in a patient with acute scrotal pain cannot exclude the diagnosis of acute testicular torsion" (*3*). However, with the further observations presented in this paper, it has become clear that a photopenic area of relatively decreased vascularity will replace the testicle in the scrotal scan performed even in the first few hours after the spermatic cord twists. Images obtained after careful establishment of hemiscrotal symmetry are extremely important, since the asymmetry of testicular vascularity is not always obvious when there is no reactive halo of increased activity in the dartos.

To test our hypothesis that a normal scrotal image indicates the absence of acute torsion, 50 examinations—including 22 cases of early torsion, 14 cases of late torsion, and 14 normal studies—were mixed randomly. The scrotal scans were reviewed by one of the authors (L.H.) without historical or pathological information. No evidence of decreased testicular or increased dartos activity was noted in any of the 14 normal studies, whereas all patients with acute torsion had abnormal examinations. The results were recorded on a scale of 0 to 3 as follows:

For the activity in the testicle,

"0" if equal to the activity in the opposite testis, "−1" if less than that of the normal testicle but still more than that of the thigh, "−2" if equal to that of the thigh, and "−3" if less than that of the thigh;

For the activity in the dartos,

"0" if not increased; "+1" if mildly increased; "+2" if equal to that of the femoral artery, and "+3" if more than that of the femoral artery.

With these criteria, we correlated the activity in the testicle and dartos with the viability of the compromised testicle. As shown in Fig. 24, decreased testicular vascularity ("−1" or "−2") was noted in both early and missed torsion. The more increased activity in the dartos, the less chance that the testicle was salvageable. In our study, when the activity of the dartos was "+2" or greater, only 15% of the testicles were viable. The scrotal scan of a 29-yr-old man complaining of acute, intermittent scrotal pain of 3 days, showed a "−2" photopenic testicle, but only "+1" dartos activity. Surgery was performed immediately and his testicle was salvaged even 72 hr after these clinical symptoms first appeared. We emphasize the importance of immediate surgery when testicular torsion has been diagnosed, especially when the activity of the dartos is less than "+2".

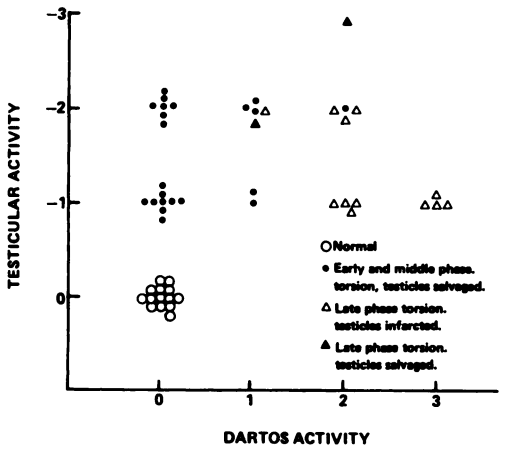

FIG. 24. Correlation of testicular viability with dartos activity and testicle activity in 50 images. Fourteen normal (O), 22 early and middle-phase testicular torsion (●), and 14 late-phase testicular torsion (△).

If normal RSI in patients with acute scrotal pain is observed, the differential diagnosis will be manual or spontaneous untwisting before the image, torsion of testicular appendages, mild trauma, emotional problems, or referred pain.

Importance of technique. Since slight asymmetry of testicular activity is often the only finding in early acute testicular torsion, the importance of technique deserves particular emphasis.

We use a converging collimator. The scrotum and its contents are relatively small structures. With a parallel-hole collimator one cannot detect small lucent areas in the scrotum or define vessels clearly. With the low-sensitivity pinhole collimator, it is impossible to do a flow study. We therefore choose the converging collimator because it combines adequate spatial resolution and satisfactory sensitivity. In infants or very young children, we do prefer to add a pinhole image for better detail after the flow study (*27*).

Symmetry is very important, especially in unilateral scrotal swelling. We use micropore tape to pull the hemiscrotum to the ipsilateral thigh and center the median raphe.

We obtain a lead-shielded image immediately after the routine tissue-phase image. In 26% (64/246) of the studies in this series, the lead-shielded images helped to provide new information or to improve diagnostic confidence. This was especially so in the patients with hydroceles. In 19% (46/246) of studies, the lead-shielded images did not demonstrate lesions as well as the immediate tissue-phase image. In 55% of the studies, there were no differences between images with shield and those without. It is important to re-establish anatomical symmetry after the lead has been positioned. We do not use the lead shielding during the flow study because it obscures vessels and can distort anatomy. Five-second images have consistently provided us adequate data for spatial resolution, with enough temporal resolution for accurate bolus, arterial phase, and venous-phase delineation.

Abscess and missed testicular torsion. Patients with acute scrotal pain who did not seek medical advice until 5–7 days after their pain began—or patients who were initially treated with antibiotics and have not improved—are referred for radionuclide scrotal imaging. The three common diagnostic considerations are missed testicular torsion, suppurative epididymitis with abscess formation, and slowly resolving epididymitis. The scrotal image (tissue phase) alone can sometimes be misleading. Increased dartos activity with a center of decreased radioactivity is the usual finding in both missed testicular torsion and abscess. The RNA, however, can clearly separate these two lesions. In an abscess, markedly increased perfusion is noted passing through both the cord (testicular), and extra-cord vessels (pudendal arteries). In missed torsion, no perfusion through the cord vessels is seen. Occasionally some increased activity is seen passing through the pudendal artery, and sometimes a "nubbin" sign of activity just proximal to the cord twist is present, but these should not cause confusion. Using the above criteria, we can confidently separate abscess from testicular torsion.

Correlation with ultrasound. Ultrasonography has been applied to the study of testicular and paratesticular diseases (*28–36*). We have found sonography particularly helpful in evaluating trauma and scrotal masses. The details of our method and complete results will be reported subsequently. In patients with trauma, the sonogram can occasionally suggest the presence of a hematoma, as opposed to a hydrocele, and can separate intratesticular and extratesticular lesions. Small intratesticular lesions below the level of scintigraphic resolution (Fig. 22C) can also be identified. In the evaluation of scrotal mass, radionuclide scrotal imaging is used primarily to diagnose suspected inflammation or silent hydrocele, and to give an estimate of the relative vascularity of the mass. The sonogram gives information about the degree of tissue heterogeneity, which may be helpful in preoperative diagnosis. In the early phase of acute torsion, sonography is not helpful because no echogenic differences are found during the early phases after vascular compromise.

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