Correlation of Radionuclide Imaging and Diagnostic Ultrasound in Scrotal Diseases

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A retrospective study was performed to evaluate the comparative usefulness of scrotal ultrasound imaging (SU) and radionuclide scrotal imaging (RSI) in 46 patients. The final diagnosis included four late phase and one early testicular torsion (TT), 11 acute epididymitis (AE), four subacute epididymitis (SE), six malignant tumors, ten hydroceles or other cystic lesions, and ten miscellaneous lesions. In patients with scrotal pain, 3/4 with late phase TT were correctly diagnosed by SU, while one with early TT and 11/15 with AE or SE were not diagnosed. All of them were correctly diagnosed with RSI except one with scrotal cyst. SU was able to separate cystic masses (n = 10) from solid masses (n = 9), but could not separate malignant from benign lesions. RSI had difficulty in separating cystic from solid lesions. We concluded that SU is useful in patients with scrotal mass to separate solid from cystic lesions. However, SU is unable to differentiate acute epididymitis from early testicular torsion. Therefore, in patients with acute scrotal pain, RSI should still be the first study performed.


More than 10 years’ experience with radionuclide scrotal imaging (RSI) has confirmed the value of this imaging modality in managing patients with acute scrotal pain. Two recent reviews (1,2) summarize this experience. With an understanding of the anatomic and pathophysiologic bases of the RSI findings, early testicular torsion and acute epididymitis can be accurately differentiated (3–5).

Advances in instrumentation have encouraged investigators to evaluate the use of ultrasound in the diagnosis of patients with scrotal masses (6–13), testicular torsion (13,14), diseases of the epididymis (10,11,13,15), and testicular trauma (13,16,17). The correlation of these two modalities is the subject of this communication. Both scrotal ultrasonography (SU) and radionuclide scrotal imaging (RSI) were performed in four groups of patients with relatively distinct clinical presentations: (a) acute scrotal pain, (b) subacute scrotal pain, (c) scrotal mass, and (d) scrotal trauma. Clinical protocols for the use of these modalities in different clinical situations are then suggested and their rationale discussed.

MATERIALS AND METHODS

Patient Population

From January, 1978, through May, 1983, 61 patients had SU, 232 had RSI, with 52 having both SU and RSI. Final diagnoses were obtained surgically in 26 patients and by clinical followup of at least 6 mo in 20 patients. These 46 patients (51 studies) form the data base of this report. The remaining six patients did not return to the referring physician for follow-up and were excluded from the study. The age range of the patients was 16 to 75 yr. Clinically these patients presented with: (a) acute scrotal pain (n = 17), which was of rapid onset, usually occurring within the previous 24 hr, but occasionally up to 5 days before presentation, (b) subacute scrotal pain (n = 6), which lasted in excess of 5 days, and may have been intermittent or chronic (over a month), (c) scrotal mass (n = 19) as the primary complaint, and (d) scrotal trauma (n = 4) which included patients with direct trauma.

Scrotal Ultrasonography

Three different instruments were used during the study period. In the early years (1978–1981), a static B scan gray-scale instrument utilizing a five MHz transducer with a 7-mm-diameter crystal and a short internal focus was used (32 patients). Subsequently, real time
ultrasonic scanning was done (14 patients). In three patients, a scanner with a 3.5 MHz transducer was used, and in 11 patients, a scanner with a 7.5 MHz small parts transducer was used. Five patients were examined with both static B scan and real time scanning instruments. All studies were performed with the direct contact method. No Doppler was used.

The ultrasonograms were reviewed by an experienced sonologist (G.N.K.) without knowledge of the clinical history. The size and echogenicity of the testes and epididymis and the presence and characteristics of an intratesticular or extratesticular mass, hydrocele, hematocoele, or spermatocele were recorded in each study. Skin thickness was also evaluated.

**Radionuclide Scrotal Imaging**

RSI was performed as previously described (3,4). In adults, 15–20 mCi technetium-99m pertechnetate is injected as an i.v. bolus. Six or eight sequential 5-sec frames are acquired with a gamma camera beginning with the first appearance of tracer on the persistence oscilloscope, or after a 10-sec delay following injection, whichever comes first. This is called the radionuclide angiogram (RNA) or flow phase. The scrotal scan or tissue phase image is obtained for 700k counts immediately after the RNA images are completed. A converging collimator is used for both phases.

The RSI studies were reviewed by an experienced nuclear medicine physician (L.E.H.). The interpretation of the scrotal RNA and scan followed a systematic approach, which was recently reported (1,4). The interval between the SU and RSI was <24 hr in each case.

**Normal Study**

A normal SU examination was well described (14). The normal testes are ovoid and contain homogeneous fine echogenicity of medium strength. The epididymis can frequently be seen as a dense echogenic band at the periphery of the testis.

The normal RSI has been well described (1,3). Briefly, in the RNA there is no definition of testicular or deferential vessels, which pass through the spermatic cord, or pudendal vessels which lie outside the cord. No significant activity is seen in the scrotal region. In the scrotal scan, testicular activity is symmetrical and slightly more intense than thigh activity.

**RESULTS**

**Acute Scrotal Pain (n = 17)**

The final diagnoses are shown in Table 1. All five patients with torsion were operated. In four patients with late phase torsion (1 day after scrotal pain), SU

| TABLE 1 |
|---|---|---|---|
| **Final Diagnosis** | **Number of patients** | **Lesions detected** | **Sensitivity** |
| | | SU | RSI | SU | RSI |
| Acute scrotal pain | | | | | |
| Early torsion | 1 | 0 | 1 | 47% | 94% |
| Late phase torsion | 4 | 4 | 4 | 100% | 100% |
| Acute epididymitis | 11 | 3 | 11 | | |
| Cyst | 1 | 1 | 0 | | |
| Subacute scrotal pain | | | | | |
| Subacute epididymitis | 4 | 1 | 4 | | |
| Atrophy with hydrocele | 1 | 1 | 1 | 100% | 84% |
| Normal | 1 | 1 | 1 | | |
| Scrotal mass | | | | | |
| Solid mass | | | | | |
| Malignant tumor | 6 | 6 | 6 | 100% | 75% |
| Gumma | 1 | 1 | 1 | | |
| Intratesticular hematoma | 2 | 2 | 1 | | |
| Cystic lesion | | | | | |
| Hydrocele or other cystic lesions | 8 | 8 | 7 | | |
| Atrophy with hydrocele | 2 | 2 | 1 | | |
| Scrotal trauma | | | | | |
| Hematocoele/hydrocele | 2 | 2 | 2 | | |
| Traumatic epididymitis with hydrocele | 1 | 1 | 1 | | |
| Intratesticular abscess | 1 | 1 | 0 | | |

* Sensitivity of modality is expressed as lesion detected/total lesions present.
  † SU can separate cystic from solid masses, but cannot differentiate among various types of cystic lesions or solid masses. RSI cannot always differentiate cystic from solid masses. However, certain malignant tumors, such as seminomas, often had a characteristic RSI pattern.
  ‡ RSI had typical pattern in 3/4 seminomas.
  § Three lesions were 1 cm in size and were not detected by RSI.
demonstrated increased testicular size with generally decreased inhomogeneous echogenicity (Fig. 1B). In one of these patients, an earlier SU study performed 22 hr after the onset of scrotal pain, demonstrated only slight enlargement of the testis, with subtle coarsening of the echo pattern (Fig 1A). RSI, in all four patients (five studies), had the typical “halo-like” appearance of late phase torsion, with moderate decreased activity in the testis and markedly increased activity in the dartos on delayed images (Fig. 1C). The RNA perfusion pattern demonstrated no increased perfusion through the spermatic cord vessels. Occasionally, in some patients, there may be increased perfusion through the extra-cord vessels to the scrotum in late phase torsion. Often, there is a “nubbin sign,” which is visualized as a bump of activity extending medially from the iliac artery. It may be due to reactive, increased blood flow in spermatic cord vessels, terminating abruptly at the site of the twist.

Only one patient presented with early testicular torsion. SU was performed 5 hr after onset of pain and demonstrated a normal testicle with inhomogeneous echogenicity in the epididymis. In contrast, the RSI demonstrated an avascular testicle with no increased activity in the dartos, which is the typical pattern for early torsion (1,5) (Fig. 2). Immediate surgery was performed. The testicle was purplish blue, but there was no hemorrhage or necrosis. The spermatic cord had twisted only 180°. Bilateral orchiopexy was done.

Eleven patients had acute inflammation that responded to antibiotic treatment. Pathologic results in five operated patients confirmed acute epididymitis without any evidence of testicular torsion. SU was abnormal in only three of eight patients with acute epididymitis, demonstrating an enlarged epididymis with relative coarse and decreased echogenicity (Fig. 3A). Three incidental hydroceles were seen. RSI demonstrated acute epididymitis in all eight patients utilizing previously defined criteria (1,3). Briefly, increased perfusion through the vessels of the spermatic cord and to the lateral aspect of the hemiscrotum is noted in the RNA. Linear or curvilinear increased activity to the head, body, and tail of the epididymis is seen in the scrotal scan (Fig. 3B). SU was also normal, while RSI

![FIGURE 1](image1)

**FIGURE 1**
Late phase torsion. A: Scrotal ultrasound 22 hr post onset of pain. Transverse scan. Normal right testicle contrasts to slightly enlarged left testis with coarse echoes. Right (R); Left (L). B: 3 days post onset of pain. Transverse scan. Right testicle remains normal. Left testis now is more hypoechoic with low level inhomogeneous echoes. There is good through transmission. C: Radionuclide scrotal scan 22 hr post onset of pain. Anterior view. Minimal decrease in perfusion to left testis (large arrow) is less obvious because of thigh shine through. Large halo-like increased perfusion in dartos (small arrow) is well visualized. The scan 3 days post onset of pain was similar in appearance.

![FIGURE 2](image2)

**FIGURE 2**
Early torsion. Radionuclide scrotal scan. Marked decrease vascularity of right testis (small arrow) contrasts with normal perfusion in left testis (large arrow). There is no hyperemia of dartos.
was diagnostic in three patients who had acute focal epididymitis.

One patient had a 1.0-cm hemiscrotal cyst seen on SU, which manifested itself as decreased activity in the right testicle on the RSI examination. This is a false-positive RSI examination in the diagnosis of acute torsion.

**Subacute Scrotal Pain (n = 6)**

The final diagnoses are shown in Table 1. SU was abnormal in only one of four patients with subacute epididymitis, two of whom were operated. SU demonstrated an enlarged epididymis with mixed (inhomogeneous) increased echogenicity. RSI in these four patients demonstrated focal increased activity in the epididymis.

Both SU and RSI diagnosed a left hydrocele, manifested as an extratesticular anechoic area on SU and a half-moon avascular area on RSI. One patient with subacute scrotal pain had normal SU and RSI. He had emotional problems and did well without treatment.

**Scrotal Mass (n = 19)**

The final diagnoses are shown in Table 1. The SU characteristics of the nine solid, surgically proven masses were similar demonstrating focal or diffuse inhomogeneous, mixed echogenicity in the testis (Fig. 4A). In three of four seminomas, the RNA showed increased perfusion through the testicular and pudendal arteries, which was directed centrally to the hemiscrotum rather than laterally or medially toward the epididymis. Scrotal perfusion to the involved hemiscrotum was also diffusely increased in three patients, and focally increased in one patient. On scrotal images diffuse homogeneous increased activity was present in three seminomas, and focal increased activity in one (Fig. 4B).

All ten cystic lesions were correctly diagnosed by SU, including three bilateral hydroceles; four unilateral hydroceles, two of which were associated with testicular atrophy; one multiple paratesticular cyst; one spermatcele; and one varicocele. The SU appearance of hydrocele was an echo-free area surrounding the testicle (Fig. 5A). The spermatcele, located superior to the testis, contained some low-level echogenicity reflecting the slightly more turbid nature of the fluid compared to a hydrocele (Fig. 5B). The varicocele had a serpiginous configuration and the atrophic testicles were small in size and demonstrated slightly increased homogeneous echogenicity.

In all cystic lesions, the RNA demonstrated a normal perfusion pattern. On scrotal images, primary hydroceles demonstrated a “moon” or “half-moon” shaped lucency surrounding the testicle (Fig. 5C). In spermatcele, the lucent area corresponded to the location of the spermatcele. The varicocele demonstrated a focal
area of increased tracer activity in the upper portion of the hemiscrotum. In two patients with testicular atrophy, the RNA was normal and the scrotal images demonstrated a smaller hemiscrotum with decreased overall activity.

Scrotal Trauma (n = 4)

The final diagnoses are shown in Table 1. SU in two patients with hematocoele/hydrocele demonstrated an almost echo-free area surrounding the testicle. Some echoes noted in one patient were due to blood clots. In the RNA, normal (n = 1) or mildly increased (n = 1) perfusion through the testicular arteries were noted. The blood pool or tissue phase image demonstrated a lucent area in the hemiscrotum in both cases.

In one patient with a knife injury, SU demonstrated a 12-mm intratesticular mass containing two linear dense echoes suggesting an abscess (Fig. 6). A small hydrocele was also noted. In the first of two RSI examinations, a hematocoele and scrotal inflammation were demonstrated. A second RSI three weeks later demonstrated a small lucency within the right testicle, and an abscess was drained.

In a patient with traumatic epididymitis and hydrocele, SU demonstrated a hydrocele and enlarged epididymis. The RSI appearance of traumatic epididymitis is the same as that of acute epididymitis.

DISCUSSION

Diagnostic Sensitivity of SU and RSI

The diagnostic sensitivity of SU in acute scrotal pain is only 47%, while that of RSI is 94% (Table 1). The poor sensitivity of SU in acute scrotal pain reflects the inability of SU to correctly diagnose acute epididymitis and early testicular torsion (<7 hr after onset of scrotal pain). SU also has low sensitivity (50%) in the diagnosis of subacute scrotal pain, compared with 100% sensitivity with RSI (Table 1).

The sensitivity of SU in detecting mass lesions was 100% as was the sensitivity in differentiating solid from cystic masses. Within the group of solid masses, how-

![FIGURE 5](image-url)

A: Hydrocele with atrophic testicle. Scrotal ultrasound. Transverse scan. Normal right testicle (R) is surrounded by anechoic area (arrow). Small left testicle is slightly hyper-echoic (L). There is some accentuation of echogenicity because testicle is in near field. Static B scan. B: Spermatocele. Scrotal ultrasound. Ovoid sonoluent area with suggestion of low level echoes (arrow). There is good through transmission. Real-time scan. C: Radionuclide scrotal scan. Very large photopenic area (arrow) is eccentric and almost obscures right testicle (R). Left testicle (L)
ever, SU could not differentiate late phase torsion, intratesticular abscess, intratesticular hematoma, gummata, or malignant tumor. The sensitivity for RSI for detecting mass lesions was 84%. However, malignant seminomas often had a characteristic RSI pattern consisting of increased perfusion through the cord vessels directed centrally to the hemiscrotum with diffuse homogeneous increased activity on scrotal images. RSI could not detect two small cystic lesions and one intratesticular hematoma. All three were <1 cm in diameter and were well demonstrated on SU. The definition of all cystic lesions was also better with SU.

The diagnostic sensitivity in scrotal trauma for SU was 100% and for RSI 75% (Table 1). The advantage of SU was in detecting the small hydrocele or intratesticular hematoma and/or abscess, which could not be detected with RSI.

Evaluation of Acute Scrotal Pain

The anatomic changes of disease often appear later than the pathophysiologic changes. In an animal study of early testicular torsion, Bird et al. demonstrated that 4 hr after occlusion of the dog’s testicular vessels, the affected testicle was enlarged with a slightly inhomogeneous, generalized decrease in echogenicity (14). However, this finding was very subtle and with the normal variation of testicular size and acoustic texture, these minimal findings when present are difficult to evaluate. The SU appearance of early torsion is also very similar to that of orchitis which also presents as acute scrotal pain (8,14). Other investigators have found it impossible to separate early torsion from epididymo-orchitis (7,13). Based on our limited experience, there was no significant difference between the normal and affected testicle in the SU of the patient with early torsion examined 5 hr after the onset of scrotal pain. In our patient presenting 22 hr after onset of scrotal pain, SU demonstrated an enlarged testicle and slight decreased echogenicity (Fig. 1A). However, RSI in this patient was very typical of middle phase (7–22 hr) testicular torsion (Fig. 1C), with little room for misinterpretation. Other investigators have also suggested that RSI is the most accurate method for the diagnosis of testicular torsion (2,18).

The classic SU finding in acute epididymitis is an enlarged epididymis with relatively decreased and coarse echoes. When epidymal enlargement occurs in the head, it is easily detected. However, enlargement of the body or tail portion of the epididymis is not as easy to appreciate. Moreover, the changes of slightly decreased and coarse echoes often cannot be noted because of the normal acoustic texture of the epididymis. In contrast, the RSI findings in acute epididymitis or acute focal epididymitis are very typical and easily appreciated (1,4,5).

Based on the above discussion, and the difficulties often experienced in performing SU on patients with acute scrotal pain, we suggest that RSI be the first study performed (Fig. 7). We reserve SU for complicated cases with scrotal pain and mass, and occasionally to verify whether a “photopenic” lesion represents an ischemic testicle or a tense hydrocele.

Evaluation of Scrotal Masses

SU has better anatomic resolution than RSI; this is especially true for the newest equipment utilizing 7.5
MHz transducers. The smallest lesion detected in our study was 0.5 cm. SU could easily separate intratesticular from intratesticular masses, but could not reliably distinguish benign from malignant lesions. When tumor, for example, totally replaced the testicular parenchyma, SU demonstrated an irregular echogenic structure which could not be distinguished from chronic torsion. In this study, two cases of malignant tumor were interpreted as chronic testicular torsion or abscess, while one case of intratesticular hematocele was thought to represent malignant tumor or chronic torsion. In the evaluation of a scrotal mass, RSI is helpful in diagnosing inflammation, chronic testicular torsion, and silent hydrocele. The RSI pattern of seminoma is also relatively typical. In addition RSI can give an estimate of the relative vascularity of any mass.

Based on the above analysis, we suggest that SU be the first diagnostic study in evaluating patients with a scrotal mass (Fig. 8). RSI can be used when inflammation, chronic torsion, or seminoma is suspected.

**Evaluation After Scrotal Trauma**

SU has been noted to be an effective method to detect intratesticular hematocele and hydrocele (13, 16, 17). In the early phase of hematocele, a transonic cystic lesion is noted. As the hematocele becomes chronic in nature, more echogenicity and solid mass appearance will be found.

The RSI pattern of scrotal trauma reflects the type and severity of the trauma (4, 5). In mild trauma, minimal diffuse increased activity in the involved hemiscrotonium reflects the hyperemia secondary to the trauma, perhaps due to subcutaneous capillary bleeding. Hematocele or hematocele has a scintigraphic appearance similar to that of a hydrocele presenting as a photopenic lesion. Traumatic epididymitis has the same scan findings as acute epididymitis. In the five studies performed on patients with scrotal trauma, RSI could detect hematocele, acute epididymitis, and a large intratesticular abscess, but could not evaluate intratesticular lesions less than 1.5 cm.

Based on the above data, we suggest that SU be the first study performed in patients presenting with scrotal trauma. RSI will be utilized to evaluate the symptomatic patient with a normal SU study, to clarify a confusing case, for followup after medical or surgical treatment, and in those patients who cannot tolerate the transducer pressure associated with the SU examination.

**Note**

Since the preparation of this report, additional improvements in ultrasound equipment have been introduced into clinical practice. The increased detail now available may allow better differential diagnosis of solid masses, and may even allow evaluation of the testis and epididymis in patients with acute scrotum. Further work in these areas is warranted and is currently underway in our institution. Preliminary experience, however, suggests that the conclusions drawn in this report are still valid.

**FOOTNOTES**

1. Picker International (EDC 80 L), Highland Heights, OH.
2. ATL, (Mark III), Bothell, WA.
3. Diasonics (Wide VUE Scanner), Milpitas, CA.

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