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Original Research Article

Role of high resolution sonography and color Doppler flow imaging in the evaluation of scrotal pathology

Ashish Kumar Gupta*, Shrinuvasan S., Srikanth Sanjeev Shetty, Chidambaram R.

Department of Radiodiagnosis, Sri Lakshmi Narayana Institute of Medical Sciences (Affiliated to Bharath University) Osudu, Puducherry, India

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***Correspondence:**
Dr. Ashish Kumar Gupta,
E-mail: docaashishgupt@gmail.com

ABSTRACT

Background: Scrotal swelling and pain are frequently encountered in clinical practice. Although to reach a diagnosis in some patients, history and physical examination are adequate, yet in a large percentage of patients, some additional studies are essential for complete evaluation of their symptoms. The clinical examination is often misleading or non-specific. The study shows the application of Gray-scale sonography, Color Doppler flow imaging (CDFI) and Power Doppler (PD) in the diagnosis of swelling, malposition, torsion, trauma, varicocele, hydrocele, cyst, mass, and atrophy.
Methods: A total of 93 patients from all age groups with symptoms related to scrotal disease have been included in this study. Gray-scale sonography, CDFI and PD sonography of scrotal lesions were carried out.
Results: A good correlation was seen in the comparison of scrotal lesions between sonography (gray scale, CDFI, and PD) and histopathology/ treatment response.
Conclusions: High-resolution sonography, along with color Doppler flow imaging and power Doppler should be used as the first-line investigation in the evaluation of scrotal pathologies. Color Doppler flow Imaging and power Doppler add useful information and complement gray-scale sonography in reaching a correct diagnosis.

Keywords: CDFI, Gray-scale sonography, Power Doppler, Scrotum, Testis

INTRODUCTION

Scrotal swelling and pain are frequently encountered in clinical practice. Although in some patients, history and physical examination are adequate to reach a diagnosis, yet in a large percentage of patients, additional studies are required for complete evaluation of their symptoms. The clinical examination is often misleading or non-specific.

Patients who present with acute onset of scrotal pain pose a diagnostic dilemma for the clinician. Traditionally, early exploration has been advocated. However, this may result in numerous needless operations, since it has been estimated that almost 80% of acute scrotal processes are inflammatory in nature. In 1974, Miskin and Bain first reported the use of B-mode ultrasonography to examine testes and scrotum.[1]

Dramatic advances within the last two decades in sonographic technology and instrumentation have been responsible for the emergence of ultrasonography as an indispensable diagnostic tool for evaluation of scrotal pathology. The indications for examination are many: – palpable mass (hydrocele, epididymal cysts, tumor, inguinal hernia, varicocele), pain (infection, torsion, trauma), infertility (hypogonadism, varicocele), cryptorchidism (undescended testis), follow up with the previous disease, and search for a possible primary tumor

in a young man with retroperitoneal masses or in a man with the previous history of undescended testis.

High–resolution real-time ultrasound has demonstrated a high degree of accuracy and sensitivity in the detection, characterization, and localization of intrascrotal abnormalities.

High–resolution real-time ultrasound has made it possible to noninvasively image and evaluate small vessels in superficial organs. To date, the superficial organ in which CDFI has the greatest impact is the testis. It has narrowed the number of clinical diagnostic possibilities considered in the differential diagnosis and thus limited the need for the surgical exploration of the scrotum and helped to make a specific diagnosis in cases to reveal the acute scrotal pain.

With all advances in technology such as amplitude coded Color Doppler flow imaging (CDFI) or Power Doppler (PD), our ability to assess blood flow and more importantly, abnormalities that after flow in both large and small vessels of testes has increased.

Power Doppler has been found to be more sensitive than color Doppler flow imaging in the detection of intratesticular blood flow. With power Doppler testicular blood flow in healthy children is symmetric, Underscoring that the blood flow in the asymptomatic testis can be used as a baseline for assessing flow in the symptomatic testis.

Computed tomography for gonadal examination is not recommended as it employs ionizing radiation. The role of CT in scrotal pathology is confined to the staging of testicular tumors by detecting the exact position of retroperitoneal lymph nodes.

Magnetic resonance imaging (MRI) sequence allows display of normal scrotum and its contents with exquisite anatomic details. Its wide field of view allows simultaneous assessment of both right and left hemi scrotal contents and inguinal regions, offering a distinct advantage over ultrasound. Its high contrast, and spatial resolution allows differentiation of the testes, epididymis, and spermatic cord. However, the disadvantages of MRI are its expense; longer examination time required and image degradation by patient motion.

Testicular scintigraphy has high sensitivity and specificity in the diagnosis of testicular torsion. However, it is limited by its poor resolution, lack of structural information, high cost, and use of ionizing radiation. Color Doppler flow imaging combines the strengths of both testicular scintigraphy and gray scale sonography.

The present study was undertaken to evaluate the usefulness and accuracy of high-resolution sonography, Color Doppler flow imaging and Power Doppler techniques in scrotal abnormalities and to use this multifold data to reduce diagnostic difficulties of these cases.

Aims and objectives

- To determine the imaging characteristics and efficacy of real-time, grayscale sonography in the detection of scrotal lesions.
- To evaluate the sonographic features in characterization, nature (cystic or solid) and the vascularity of these scrotal lesions.
- To classify scrotal lesions whether intra testicular or extra testicular.
- To differentiate between benign and malignant nature of a known scrotal mass and to correlate the sonographic findings with guided FNAC and or biopsy wherever indicated.

METHODS

The study has been conducted on a total of 93 patients from all age groups for two years in the Department of Radiodiagnosis in association with Department of Surgery, Sri Lakshmi Narayana Institute of Medical Sciences, Medical College, and Hospital.

Clinical assessment

Relevant history was taken about clinical symptoms and the presenting complaints. Bimanual palpation was performed in all cases in order to determine the status of scrotal contents. Fluctuation, reducibility and transillumination tests were done as and when required. Sites of possible metastases were examined in cases with suspected testicular tumors.

Radiological examination

Sonography

Gray-scale sonography, CDFI and PD sonography of the scrotal lesions were carried out using linear / sector array high frequency 7 to 12 MHz transducers. At times, 5 or 3.5 MHz transducers were necessary for adequate penetration, particularly with large scrotal swellings.

Inclusion criteria included all cases with clinical manifestations of the testicular pathology of all age groups. Exclusion criteria involved all cases with lacerated trauma.

Technique

The scrotum and the spermatic cord were scanned from anterior, lateral and inferior surfaces in the longitudinal and transverse plane. In cases of varicocele, the examination was performed in a supine posture, with Valsalva maneuver, and in the erect posture to confirm it. Masses were imaged in multiple planes and documented. For gray scale imaging, meticulous attention was given to

set gains and time gain compensation (TGC) to prevent masking of pathology and to maximize contrast resolution respectively. Comparison with the contra lateral testis was helpful to demonstrate subtle changes in echo texture.

Color Doppler flow imaging and power Doppler

Thereafter, CDFI was performed to depict flow in the vessels. The testicular artery, capsular arteries, intratesticular vessels and cremasteric vessels were identified where possible. The Doppler controls were optimized to detect low flow. The scale of pulse repetition frequency (PRF) was set as low as possible, wall filters set low or removed and the color Doppler gate set as wide as possible. The color gain was set high and then adjusted until background "noise" just disappears. Thereafter, PD mode was applied to the area of interest. The PD settings were adjusted so that scale or PRF is low, color window small and the color gain just below that which induces background noise.

Sometimes, it was helpful to perform pulsed Doppler spectral analysis. In such cases, the examination was aimed such that angle of insonation beam was minimal and without steering.

The comparison was always made with the asymptomatic side and finding analyzed in the opposite pathological side.

In patients with suspicion of testicular tumors, the kidney, liver and paraaortic regions were scanned to look for the presence of secondaries and backpressure changes in the kidneys. In the case of varicocele also, the kidneys, especially the left were scanned to rule out renal mass.

The following sonographic parameters were studied in each case:

- Scrotal skin-thickening or swelling.
- The position of the testes.
- The size of the testes with regards to transverse, antero-posterior and superoinferior measurements.
- Echo pattern of the testes.
- Position, size and echo pattern of the epididymis.
- The Fluid collection, if any: its echomorphology and its relation to testes.
- Inguino-scrotal region for evidence of any varicocele or a hernia.
- Vascular anatomy with quantitative and qualitative data: grades of vascularity, the pattern of blood flow, PSV, EDV & RI.

The vascularity of the lesion was evaluated with both color and power Doppler as follows.

Grade 0: No Doppler signals in the evaluated scrotal structure/mass.

Grade 1: Spotty Doppler signals in the evaluated scrotal structure/mass.

(<2 vascular signals per 10 mm)

Grade 2: Scattered Doppler signals in the evaluated scrotal structure/mass.

Grade 3: Continuous flow (uninterrupted vessels >25mm in length).

Chest radiograph (PA view)

It was taken in those cases, which were suspected to have a testicular tumor, to look for metastases and in suspected tuberculous epididymitis.

Computed tomography

CT abdomen was done in a patient with testicular tumors to detect retroperitoneal lymph nodes and metastases.

Laboratory investigations

- Relevant investigations, like urine-routine/microscopic examination and culture, ESR and ELISA for tuberculosis, aspirated fluid microscopy and biochemical analysis was done wherever indicated.

- USG guided FNAC or biopsy was carried out, wherever indicated.

Finally, analysis keeping in the mind, correlation of clinical findings with sonography was done. The effectiveness of CDFI and PD in various lesions was evaluated. Stress was laid on a correlation of palpable findings with the sonographic examination.

In 68 patients the sonographic findings were correlated with histopathology. Other patients were followed up sonographically and clinically.

RESULTS

A total of 93 patients referred for pathological conditions of scrotum were evaluated using high-resolution grayscale sonography, Color Doppler flow imaging (CDFI) and Power Doppler (PD).

The age of these patients ranged from 3 months to 72 years (Figure 1).

The most frequent symptom was scrotal swelling (36.3%) followed by scrotal pain (22.9%) (Figure 2).

Bimanual palpation revealed important clinical signs. Relevant signs and their frequency are illustrated in Table 1.

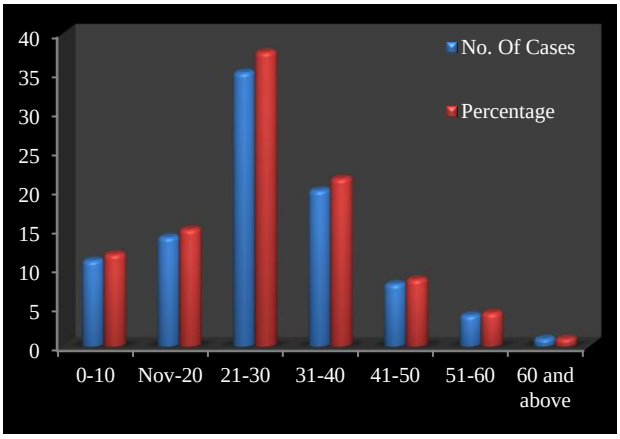

Figure 1: Age distribution of the cases.

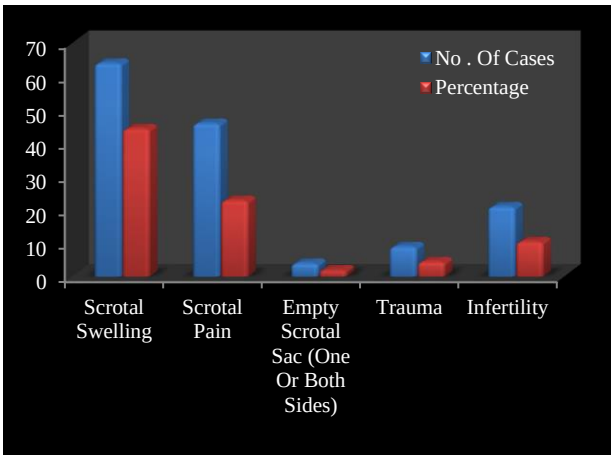

Figure 2: Clinical symptomatology

Table 1: Clinical signs.

Clinical signs	No. of cases	Percentage
Positive transillumination test	32	26.2
Fluctuation	21	17.2
Reducibility	6	4.9
Thrill on coughing	4	3.3
Expansile impulse on coughing	4	3.3
Localized epididymal swelling	23	18.8
Absent testicular sensations	4	3.3
Tenderness of scrotal swelling	24	19.7
Enlarged supraclavicular lymph nodes	1	0.8

The distribution of the cases is depicted in the following table according to the pathological nature of the lesion. Hydrocele was the commonest abnormality noted. Inflammatory lesions accounted for most of the cases besides hydrocele. Testicular tumors comprised only 4.2% of the study group (Table 2).

The tumors measuring more than 1.6 cm in size were hypervascular in all cases, while those less than 1.6 cm were hypovascular as compared to surrounding parenchyma or contra lateral testes.

Table 2: Distribution of cases according to pathology (N=144)*

Nature of lesion	No. of cases	Percentage (%)
Scrotal pain		
Inflammation		
Epididymitis	18	12.5
Epididymo-orchits	16	11.1
Scrotal wall edema	2	1.4
Abscess	1	0.6
Non inflammation		
Torsion testis	3	2.1
Testicular trauma	4	2.9
Painless scrotal mass or swelling		
Extratesticular		
Hydrocele	38	27.1
Hematocele	3	2.1
Pyocele	1	0.7
Testicular & epididymal cysts	13	9.3
Varicoceles	15	10.4
Hernias • Omentoceles • Enterocele	 3 4	 2.1 2.8
Intratesticular		
Testicular tumors	6	4.2
Testicular atrophy	6	4.3
testicular microlithiasis	3	2.1
Others		
Malpositioned testis	5	3.6

*Some of the patients had more than one lesion.

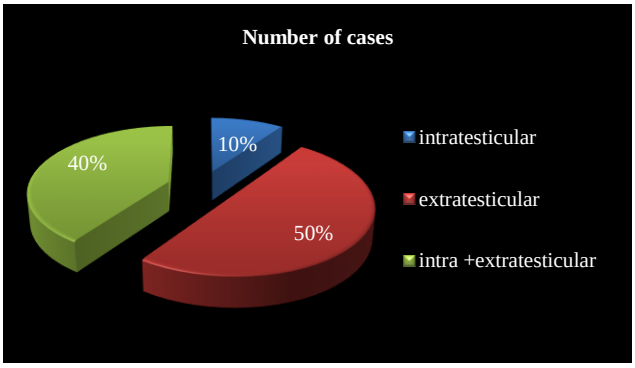

Figure 3: Incidence of intratesticular/extratesticular lesions.

Table 3: Sonographic features in testicular tumors.

Sonographic features	NSGCT (n=2)	Seminoma(n=2)	Terato Ca (n=1)	Azzo- Tm (n=1)	P Value
Testes					
Size					
• Normal	---	-----	1	1	0.1817
• Earliest	2	2	----	---	0.079
Involvement					
• Focal	---	----	1	1	0.1817
• Diffuse	2	2	-----	-----	0.079
Echotexture	Heterogeneous, Cystic & hyper echoic areas	Relatively homogenous cystic areas on HRS	hyper echoic	hyper echoic	
Tunica invasion	2	2	------	-----	0.079
Calcification					
• Present	------	-----	------	-----	0.0138
• Absent	2	2	1 (microlith)	1	
Contralateral testes	Normal	normal	Test. Microlithiasis	Normal	0.0154
Adnexal structures					
• Epididymis	Thickened (n=2)	Normal	Normal	Normal	0.0138
• Spermatic cord	Thickened (n=2)	Normal	Normal	Normal	0.0138

Table 4: CDFI features of testicular tumors.

Features	NSGCT	Seminoma	TeratoCa	Azzo.tm	P value
Size of lesion					
• Less than 1.6 cm	-----	-----	1	1	0.1817
• More than 1.6 cm	2	2	-----	-----	0.079
Cdfi findings					
Grade 0 - no flow	---	---	1	1	0.079
Grade 1 – spoty flow	--	---	---	----	
Grade 2 – multiple scattered flow	1	1	---	----	0.01817
Grade 3 – continuous flow	1	1	---	---	0.01817
Pattern of flow	Unevenly distributed vessels	Unevenly distributed vessels	----	----	0.018
Spectral analysis					
Psv> 19.8 cm/second	2	2	---	---	0.079
Ri<0.7	2	2	---	---	0.079

Table 5: Associated findings in cases of testicular tumors.

Findings	NSGCT	Seminoma	TeratoCa	Azzo.tm
Lymph node				
Site				
Paraaortic	2	1	1	0
Peripancreatic	2	0	1	0
Periportal	1	0	1	0
Iliac	1	0	1	0
Size	Bulky (>6cm) Confluent	Bulky (>6cm) Confluent	Large discrete	---
Liver metastasis	1	---	---	---
Lung metastasis	1	----	---	---
Hydrouretero-nephrosis	1	---	---	---

Table 6: Representation of final outcome.

Lesion	Clinical diagnosis	CD	Intervention	Final outcome
Epididymitis/ epididymo-orchitis	38	36	Antibiotic	Epi/Epi-orch
Cord injury	2	4	Antibiotic	Injury
Torsion	3	3	Surgery	Torsion=3
Masses	19	19	FNAC	Tumor=6 Cystic=13
Varicocele	15	15		Varicocele
Hydrocele	38	42	Aspiration	Hydro=38 Hemato=3 Pyoce=1
Malposition	5	5	Surgery	Malposition

Table 7: Statistical Analysis Using P Value (MedCalc – version 16.8.4): Sensitivity and specificity of color Doppler ultrasonography in diagnosis.

7(a): Scrotal diseases.

Data	Scrotal disease		
	Disease present	**Disease absent**	**Total**
Test positive	93	0	93
Test negative	0	4	4
Total	93	4	97
Results			
Sensitivity	100%	96.11% to 100%	
Specificity	100%	39.76% to 100%	
AUC	1.00	0.96to 1.00	
Positive likelihood ratio	-	-	
Negative likelihood ratio	0.00	-	
Disease prevalence	95.88%	89.78% to 98.87%	
Positive predictive value	100%	96.11% to 100%	
Negative predictive value	100%	39.76% to 100%	

7(b): Scrotal masses.

Data	Scrotal masses		
	Disease present	**Disease absent**	**Total**
Test positive	6	0	6
Test negative	4	3	7
Total	10	3	13
Results			
Sensitivity	60%	26.24% - 87.84%	
Specificity	100%	29.24% -100%	
AUC	0.80	0.49 to 0.96	
Positive likelihood ratio	-	-	
Negative likelihood ratio	0.40	0.19-0.85	
Disease prevalence	76.92%	46.19%- 94.96%	
Positive predictive value	100%	54.07% -100%	
Negative predictive value	42.86%	9.90% -81.59%	

DISCUSSION

This study was undertaken to evaluate the multifold data obtained by high-resolution grayscale sonography, and Color Doppler flow imaging in the evaluation of scrotal pathology. Ninety-three patients with evidence of lesion in scrotal structures were included in this study.

The scrotal pathologies were commonest in young males. The chief complaint was scrotal swelling followed by scrotal pain. Out of the 93 patients included in the study, 144 pathological lesions were observed. The final diagnosis was fluid collections in 42 cases, acute and chronic inflammations in 16 and 18 cases, testicular tumor in 6 cases, torsion of testes in 3 cases, malpositioned testes in 5 cases, testicular trauma in 4 cases, testicular and epididymal cysts in 17 cases, varicocele in 15 cases and the rest were miscellaneous lesions including testicular atrophy, testicular microlithiasis, hernia and scrotal wall thickening.

Out of 93 patients, cryptorchidism was noted in 5.3% with the most common location being the inguinal canal (60%. of the right side was predominantly involved). Three testes (60%) were homogeneous and hypo echoic. One case showed Torsion of undescended testes. Two testes demonstrated grade I vascular signals as compared to grade II on the contra lateral side. Kleinteich et al reported location of cryptorchid testes in inguinal canal in 72% and abdominal in 8% cases (Figure 1a).[2]

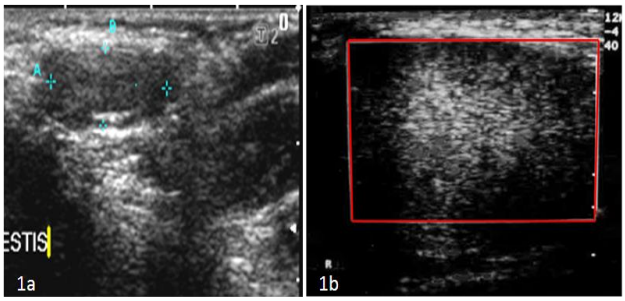

Figure 4: Cryptorchidism and torsion (a) Grey scale sonography shows left testis noted just near the left inguinal canal near the superficial inguinal ring, small in the size and hypo echoic in echo texture; (b)On Doppler study, no vascularity was noted in right testis, feature suggestive of torsion.

Idiopathic hydrocele was the commonest abnormality noted. It featured mostly as an anechoic collection in tunica vaginalis cavity. Martin et al also described similar sonographic features in hydroceles of the spermatic cord.[3] On CDFI and PD the vascularity of the underlying testes was maintained in idiopathic hydroceles. However, reduced diastolic flow was noted in 5 cases of large hydroceles. Nye and prati also reported a case of large idiopathic hydrocele with RI of 1.0 without any evidence of coexisting disease (Figure 2a-c).[4]

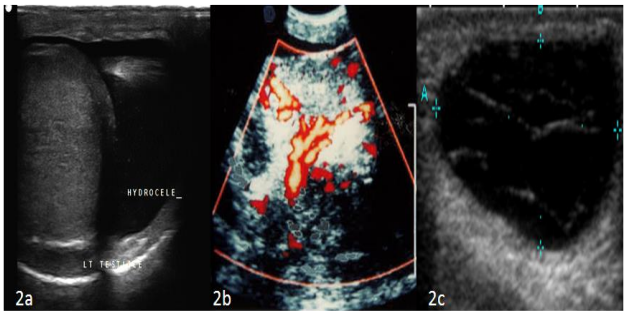

Figure 5: Hydrocele / hematocele / pyocele; (a) Grey scale sonography with 6 MHz transducer shows a large hydrocele dividing in two sacs – hydrocele En Bisac; (b) Post operative patient of hydrocele showing an heterogeneous collection in right scrotum with vascularity-hematocele, (c) and patient with dense heterogeneous collection- pyocele.

Fifteen cases of unilateral varicoceles were seen. Of these 13 cases (86.7%) were noted on left side. Maximum vessel diameter was > 4 mm in 6 cases (40%). All cases demonstrated accentuation on Valsalva maneuver and on assuming erect posture. Color Doppler was found to be more sensitive than clinical examination to detect varicoceles. Grade III reflux on Valsalva maneuver was noted in 11 cases (73.3%). Greenberg et al found reflux in all 75 men with clinical varicoceles.[5] No significant difference in PSV in relation to presence or absence of varicocele and the degree of reflux was noted. Similar observations were noted by Grasso et al (Figure 3a and b).[6]

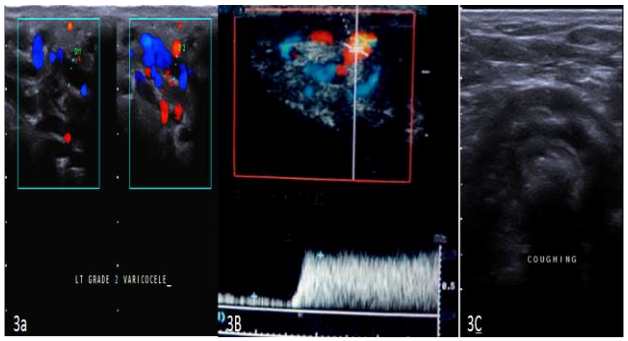

Figure 6: Varicocele and hernia; (a) Grey scale sonography shows multiple dilated anechoic channels are seen in the spermatic cord. Color Doppler during valsalva; (b) Spectral analysis of patient shows venous flow with reflux on Valsalva maneuver in varicocele. (c)Grayscale ultrasound shows left superficial inguinal ring defect on staining shows bowel as its content.

Hamm et al had reported an incidence of 4% of testicular cysts.[7] Three cases of testicular cysts were seen as well circumscribed, an anechoic cystic structure with thin smooth walls as compared to cysts seen in testicular tumors which were multilocular with shaggy, thick poorly marginated walls. Similar findings were described by Gooding et al.[8]

Six cases of spermatoceles and eight cases of epididymal cysts were noted. Both these conditions were not reliably distinguished on sonographic examination alone. Cysts contents were echogenic in 83.3% cases of spermatoceles and anechoic in 100% cases of epididymal cysts**.** Doherty et al noted similar findings. Both these lesions were common in the head of the epididymis. A Similar concern was shown by Krone et al and Langer et al**.**[9-11]

Omentoceles was seen in 3 cases and enteroceles in 4 cases. Thus an incidence of 7.5% was noted. An incidence of 7.6% was noted by Subramanyam et al in their study Sonography revealed a highly echogenic mass separated from the testes in omentocele and anechoic mass with visible peristalsis in the inguinoscrotal region in case of enterocele.[12] CDFI and PD demonstrated vascular signals in bowel wall and within the omenta. CDFI and PD were also found useful in the evaluation of

complications following inguinal hernia repair. Hollaway had similar observations (Figure 3c).[13]

In the case of acute inflammations, the commonest pattern was diffuse involvement of testes, which was hypo echoic. Focal involvement of epididymal head was noted in 62.5% cases with hypoechogenicity in 43.8% of cases. Spermatic cord involvement was less frequent. Some amount of peritesticular fluid was noted in 50% of these cases. Horstman reported the involvement of testes in 20% to 40% of cases with focal involvement in 10% of cases.[14]

On CDFI and PD hypervascularity of involved testes was noted in 61.3% and 87.5% cases, respectively. In epididymis, CDFI demonstrated hypervascularity in 49% cases while PD showed hypervascularity in 87.6% cases. Thus power Doppler was proved more sensitive than color Doppler in detecting inflammatory pathology. PSV more than 15 cm/sec and RI less than 0.7 were complementary to the diagnosis of acute inflammations. Brown et al also concluded from their study that a PSV >15cm/sec produced a diagnostic accuracy of 90% for orchitis and 93% for epididymitis (Figure 4a and b).[15]

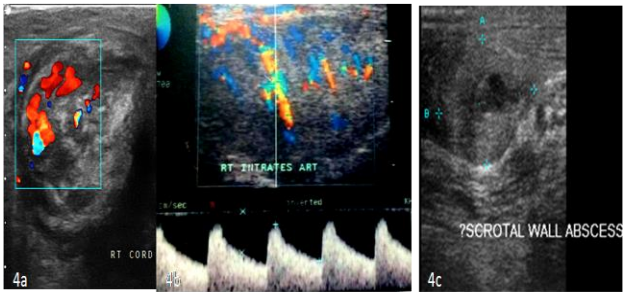

Figure 7: Epididymo-orchitis and abscess; (a) Grey scale sonography shows hypo echoic enlarged thickened right cord on Doppler diffuse hyper vascularity of the cord noted; (b) Spectral analysis of the case shows increased PSV (48.2\sec) and reduced RI (0.52) suggestive of high flow with impedence. (c) Grey scale sonography shows Scrotal wall appears thickened and shows an abscess measuring 2.3 x 1.9 cm.

Chronic inflammations including tuberculous epididymo-orchits were more common than acute inflammation of scrotal structures. In these cases, epididymal involvement was observed to be for more common than involvement of testes. The tail of the epididymis was frequently involved, as also the involvement of spermatic cord. The epididymis was mostly hypo echoic in involved cases. Strikingly similar observations were noted in patients with tuberculous and non-tuberculous epididymo-orchitis by Kim et al in a study of 123 patients (Figure 7).[16]

The epididymal lesions were hypervascular on CDFI and PD in nearly 70% of cases. PSV >15 cm/sec and RI <0.7 were less reliable for diagnosis as compared to the reliability of these criteria in acute inflammations. Power Doppler was more sensitive than CDFI in depicting hypervascularity of the lesions and to detect early inflammations. Increased sensitivity and specificity of CDFI to assess scrotal inflammation has been asserted by Brown et al.[15] No such study has been conducted to define the role of PD in chronic inflammations and its comparison with CDFI.

The most important role of CDFI and power Doppler was noted to differentiate equivocal gray-scale sonographic features of testicular torsion and acute inflammations. With CDFI symptomatic testes showed the absence of vascular signals in 3 cases. In this single case of a prepubertal child, it was possible to demonstrate vascular signals on the asymptomatic side by power Doppler. Tumeh et al described intravaginal torsion to occur commonly between the ages of 12 to 18 years.[17] Spectral analysis revealed a decrease in RI with dampened flow in two patients and non-pulsatile 'venous' waveform in one. Bird et al remarked that sonographic features of torsion might be indistinguishable from those of inflammation (Figure 1b).[18]

Discrete fracture plane was seen in one out of four patients (25%) of testicular trauma. Jeffrey et al[19] noted similar findings in testicular trauma with the identification of fracture plane in two out of twelve patients No vascular signal was identified in this case on CDFI and PD.[19] Dewire et al also noted absent vascularity in 25% cases of testicular trauma in their study of four patient.[20]

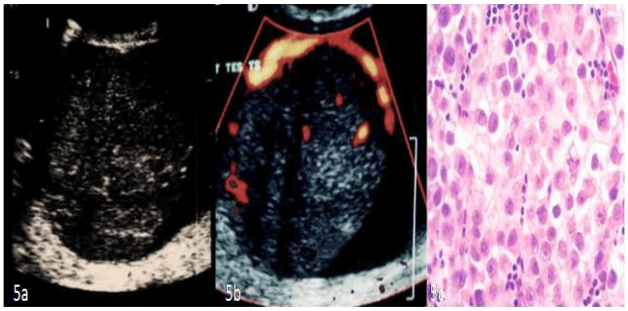

Figure 8: Seminoma (a) Longitudinal and transverse scans though Rt. Testis depict grossly enlarged testis with relatively homogenous and hypo echoic parenchyma replacing the entire testis. A case of seminoma testis; (b) On color Doppler and PD the mass lesion was hypervascular (grade III) with large vessels in disorganized manner. (c) HPE shows clear tumor cells and lymphocytes- suggested seminoma.

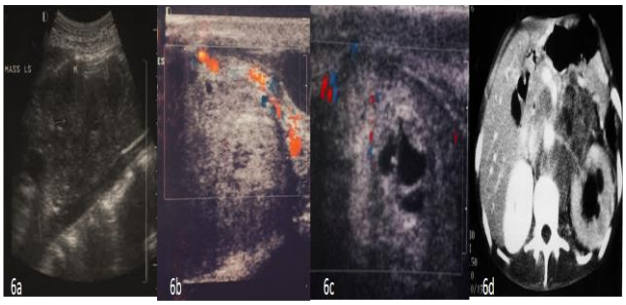

Figure 9: NSGCT; (a) The patient presented with abdominal lump. On sonography a large hetroechoic mass lesion noted in the epigastric region anterior to aorta; (b) Associated scrotal swelling revealed a heterogeneous mass lesion with cystic and hyperechoic areas. On Doppler increased peripheral vascularity noted. (c)Multi oculated cyst with thick shaggy wall-surrounded by heterogeneous testis (d)-Large confluent lymphnodal mass is noted in the para-aortic, aorto-caval, and around renal hilum. Bilateral hydronephrosisseen.

The sonographic characteristic of testicular tumors was the heterogeneous appearance of the testes as described by Arvis et al.[21] Arger et al also reported that the hypo echoic appearance of the neoplasm is seen more commonly.[22] Non Seminomatous germ cell tumors were the commonest tumor in our study. One case each of seminoma, teratocarcinoma, and Azzopardi tumor was seen. Nonseminomatous germ cell tumor was heterogeneous in echo texture with cystic spaces. Nachtscheim et al made similar observations in their study of 17 patients with testicular tumors.[23] Mostofi et al reported extracapsular extension in 20% cases of NSGCT(Table 3-5) (Figure 5 and 6).[24]

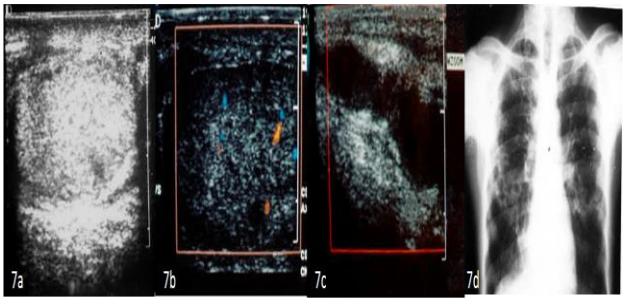

Figure 10: Testicular tuberculosis; (a) Right testis shows heterogeneous appearance with multiple hypodence area; (b) Doppler of the same patient shows multiple spotty signals. (c)The spermatic cord was thickened,hypoechoic and showed a beaded appearance. (d) Chest X ray shows fibrotic and infiltrative lesions in right upper and lower zone.

The focal hypo echoic lesion was noted in the case of teratocarcinoma and focal hyperechogenicity in a case of Azzopardi tumor. Azzopardi et al and Grantham et al reported hyper echoic foci in six out of seven regressed germ cell tumor of the testes.[25,26]

Para-aortic lymph nodes were the commonest site of metastases followed by liver and lung.

On CDFI and PD tumors less than 1.6 cm was hypovascular and tumors more than 1.6 cm were hypervascular. These findings were similar to those observed by Horstman et al.[27]

In 5 patients with testicular atrophy, the testes showed heterogeneous echo pattern in 66.7% cases and hypoechogenicity in 33.3% cases with small epididymis in all cases. Four out of six testes demonstrated noticeably reduced flow signals on CDFI and PD. Similar findings on gray scale and color Doppler flow imaging was found by Cross et al in 5 patients of testicular atrophy.[28]

Testicular microlithiasis was seen in 3 testes as a multiple small (1–2 mm), diffusely scattered hyper echoic foci within testicular parenchyma without acoustic shadowing. Doherty et al described similar findings with a reported incidence of 0.6%.[9]

Scrotal wall thickening was seen in two patients with heart failure and filariasis. Multiple layers like onion peel were seen on sonography with normal underlying testes. High resistance blood flow was noted within the scrotal wall vessels. Grainger et al described similar findings in a study on scrotal wall edema.[29]

A good correlation was seen in the comparison of scrotal lesions between sonography (gray scale, CDFI, and PD) and histopathology/ treatment response. (Table 6 and 7).

CONCLUSION

The various parameters in scrotal diseases have been studied and evaluated sonographically (gray-scale, CDFI & PD) in the background of clinical and laboratory data. On the basis of this study, the following conclusions arrive:

- Scrotal diseases were seen in all age groups with predominance in young males.
- Scrotal swellings followed by scrotal pain were the commonest clinical symptoms.
- High–resolution sonography with color Doppler flow imaging (CDFI) and power Doppler (PD) could reliably define the morphological features and vascularity of scrotal lesions.
- Sonography was highly accurate in evaluating the consistency of scrotal mass-solid or cystic. An accuracy of 100% in this regard, was achieved in this study.
- Sonography was useful in localizing scrotal abnormally as intra testicular or extra testicular. This was important, as almost all extra testicular

pathologies are benign. This was possible in 98% of our cases.

- Sonography was found to be 100% sensitive in the diagnosis of hydrocele. Furthermore, it helped in evaluating the integrity and size of testes in cases associated with large hydrocele, which is difficult clinically. Sonography could distinguish idiopathic hydrocele from that following trauma and infections.
- Inflammatory scrotal pathologies were diagnosed easily by high resolution sonography with high accuracy. The extent of testicular and epididymal involvement was reliably detected as was the presence of any associated fluid collections.
- Sonography is an ideal tool for detection of testicular tumors as proved in this study with a sensitivity of 100%.
- High resolution was 100% sensitive in detection and localization of scrotal masses. In addition, reliable detection of abdominal adenopathy was possible in case of a malignant tumor. However, a specific pathological diagnosis could not be suggested based on the sonographic findings alone. Benign cystic lesions of the testes could be reliably differentiated from cysts within testicular tumors.
- Testicular contusions, fractures, and hematoceles were accurately diagnosed by high-resolution sonography in cases of scrotal trauma.
- High-resolution sonography was found to be very accurate in localizing undescended testes.
- Cysts of the epididymis, namely epididymal cysts and spermatoceles were diagnosed with high accuracy. Although the two conditions could not be differentiated from each other based on sonographic findings.
- In the case of a scrotal hernia, the hernia contents were well evaluated by sonography. Bowel, omentum, and fat content were diagnosed and distinguished from each other.
- CDFI and PD helped in delineating the vascular status of testicular masses. However, Doppler did not add to the sensitivity of lesion detection by high-resolution sonography. Testicular tumors that were more than 1.6 cm were hypervascular and those less than 1.6 cm were hypovascular. Evidence of disorganized tumor vascularity was seen.
- Color Doppler was found extremely sensitive in the diagnosis and differentiation of testicular torsion and inflammation especially in cases of equivocal gray-scale findings. PD was found to the more sensitive than CDFI to compare the involved side with contra lateral normal side, especially in prepubertal males.
- The vascular status of undescended testes especially in prepubertal males was accurately detected by CDFI and PD.
- The important role of CDFI and PD was noted in cases with testicular trauma and in the follow-up of patients with inguinal hernia repair. Evaluation of vascular integrity of the testes was critical in the management.
- Varicoceles were accurately diagnosed using CDFI and PD.

The present study concludes that high-resolution sonography, along with color Doppler flow imaging and power Doppler should be used as first-line investigations in the evaluation of scrotal pathologies. Color Doppler Flow Imaging and Power Doppler add useful information and complement gray-scale sonography in reaching a correct diagnosis.

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