Section: Radiology

Original Research Article

ROLE OF HIGH RESOLUTION SONOGRAPHY, COLOR DOPPLER FLOW IMAGING AND POWER DOPPLER IN THE EVALUATION OF SCROTAL PATHOLOGY

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ABSTRACT

Background: The scrotum is a fibromuscular cutaneous bag that houses the testicles, epididymis, and the lowest half of the spermatic cord. Pathological conditions affecting these structures include congenital, simple inflammatory, and neoplastic diseases Scrotal swelling and pain are frequently encountered in clinical practice. Although to reach a diagnosis in some patients, history and physical examination are adequate, but some additional studies are essential for complete evaluation of their symptoms. The clinical examination is not so 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.

Materials and Methods: A total of 55 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.

Conclusion: 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. diagnosis. 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.

MATERIALS AND METHODS

The study has been conducted on a total of 55 patients from all age groups for one years (Oct 2023 to Sept 2024) in the Department of Radiodiagnosis 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 Valsalvamaneuver, 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 Gupta AK et al. Int J Res Med Sci. 2017 Apr;5(4):1499-1509 International Journal of Research in Medical Sciences | April 2017 | Vol 5 | Issue 4 Page 1501 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. (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 urineroutine/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 some patients the sonographic findings were correlated with histopathology. Other patients were followed up sonographically and clinically.

The study was carried out among 55 patients voluntarily consenting tobe a part of the study. These patients were presenting with symptoms of scrotalpathology and no known severe complications, being referred to the department of Radio diagnosis in association with Department of Surgery,Saraswati Institute of Medical Sciences and Hospital, Hapur (Uttar Pradesh).

Patients referred for pathological conditions of scrotum were evaluatedusing high-resolution gray scale sonography, color Doppler flow imaging(CDFI) and power Doppler (PD).

RESULTS

Socio-demographic profile of the study participants the age wise distribution of study participants showed that the age ofthese patients ranged from 3 months to 72 years. Maximum numbers ofpatients were of sexually active age group of 21 to 40 years. The distribution ofthe age groups is shown in Table 1. [Table 1]

The most frequent symptom was scrotal swelling (36.5%) followed by scrotal pain (22.6%).

Most of the patients had more than one symptomBimanual palpation revealed important clinical signs. Relevant signs and their frequency is illustrated in Table 3. [Table 3]

Positive trans-illumination test, which is suggestive of fluid within the scrotal sac, was seen in both hydroceles and large epididymal cysts.

Testicular sensations were absent in 2 cases of testicular tumor and cases of hematocele.

Table 4 depicts the distribution of the cases according to the pathological nature of the lesion. [Table 4]

Hydrocele was the commonest abnormality noted. Inflammatory lesions accounted for most of the cases besides hydrocele.

Testicular tumors comprised only 6.3% of the group.

Hydrocele was the commonest fluid collection noted. Out of these 31.6% were associated with inflammatory diseases of the scrotum.

In two cases of hematoceles testes could not be identified.

There was a single case of lymphocele, which also showed lymphatic collection in inguinoscrotal region. [Table 5]

Predominant masses were non-seminomatous germ cell tumors (NSGCT). All NSGCT showed grossly enlarged testes with heterogeneous echo pattern and cystic areas.

Seminoma had homogenous echo pattern on sonography.

A hypoechoic 1.4 cm lesion was noted in a patient which was later diagnosed as teratocarcinoma on histopathology. Bilateral testicular microlithiasis was noted in this case.

A patient with chronic myeloid leukemia with blast transformation was referred for sonography for scrotal pain. On gray scale sonography the testes was diffusely hypo echoic. [Table 6]

The tumors measuring more than 1.6 cm in size were hyper-vascular in all cases, while those less than 1.6 cm were hypo-vascular as compared to surrounding parenchyma or contralateral testes.

Diffuse hypervascularity of testis with leukemic infiltration was noted. [Table 7]

Most common site of metastases was to the paraaorticlymph nodes. The lymphnode masses were predominantly bulky (>6cm) and confluent.

Liver metastases were apparent on both sonography and computed tomography (CT). However, number of lesions detected was more on CT. [Table 8]

In 50% cases of acute inflammation the testes is increased in size. Diffuse involvement of testes on gray scale sonography was noted in66.6% cases. The involved testes were hypo echoic in most of the cases.

Involvement of epididymis was very common and was noted in 88.8% of cases. Focal involvement of head of epididymis was the commonest pattern.

Spermatic cord was increased in size in 33.3% cases only. Peritesticular fluid was echogenic in 11.1% cases. [Table 9]

88.8% had Grade II or more signals in tests on CDFI, while PD demonstrated these signals in 77.7%.

Epididymis was hypervascular with Doppler signals more than Grade II in 66.6%cases on CDFI and 88.8% on PD.

PSV more than 0.7 was seen in 55% cases of orchitis and 68% cases of epididymitis.

RI less than 0.7 were seen in 56.2% cases of orchitis and 62.5% cases of epididymitis. PD saw grade II or more vascularity of testicular artery and intra-testicular artery in 33.3% of cases by CDFI and in 38.9% of cases.

Epididymal involvement was common in chronic inflammation and this was reflected by hypervascularity in 66.6% cases on CDFI and 72.3% cases on PD. PSV more than 15cm/cc was noted in only 33.3% cases each of chronic orchitis and chronic epididymitis. RI less than 0.7 was noted in 22.2% of cases in orchitis and epididymitis each.

Two case of acute torsion and case of chronic torsion (history of more than 10 days) were seen. All patients with torsion were under the age of 20 years.

“Whirlpool sign” or spiral twist of spermatic cord was noted in one case of testicular torsion.

Echogenic fluid suggestive of hematocele was noted in two patients with testicular trauma.

CDFI demonstrated flow signals on asymptomatic side only in two cases (66.6%). No colour signal was identified by CDFI in a pre-pubertal child.

Power Doppler identified absent flow on symptomatic side and vascular signals on asymptomatic side in all cases.

Waveform of testicular artery was non-pulsatile and nearly “venous” in one patient.

All cases had unilateral varicocele. Varicoceles were present on left side in 6 cases and on the right in 2 cases. All patients were proven surgically to have varicocele.

Most common location of undescended testes was in inguinal canal (60%). Associated hydrocele was noted in two patients and inguinal hernia in one patient. Complication of torsion of the testes was seen in one patient

Head of the epididymis was involved in 2 cases (50%) of spermatocele and 4 cases (75%) of epididymal cysts.

Nearly 83.3% cases of spermatocele showed echogenic contents while epididymal cysts were anechoic in all cases.Vessels were seen within the septae in 2 cases of spermatoceles and 1 case of epididymal cyst.

Scrotal Hernias

Three cases of omentocele were seen in the inguinoscrostal region. They were seen as highly echogenic mass separate from the testes. Colour Doppler flow imaging and power Doppler demonstrated vascular signals within the mass, which depicted high resistance arterial flow and venous flow.

Bowel loops with visible peristalsis were seen in 4 cases. CDFI depicted vascular signals within bowel wall.

One patient operated for herniorrhaphy with multi-septated collection in the spermatic cord was seen. Poor diastolic filling in ipsilateral testicular artery with grade I vascularity of testis was noted.

Testicular Microlithiasis

This condition was seen in bothtestes in 1 patientwith an incidence of 1.8% (1/55). One patient with bilateral testicular microlithiasis had associated terato-carcinoma in one testis.

Scrotal Wall Edema

Two patients with average scrotal wall thickness 1.3cm and 2.8cm respectively were noticed. Testes were normal in both cases.

Thickening of penile skin was seen in both cases. Grade I vascular signals were seen in scrotal wall on CDFI and PD that showed RI values of 0.81 and 0.78 respectively.

Table 1: Age Distribution of the study subjects

Age Groups (Years)	No. of Cases	Percentage
0-10	6	10.9
11-20	8	14.5
21-30	20	37.0
31-40	12	21.8
41-50	5	9.09
51-60	3	5.45
61 and above	1	1.8

TOTAL	55	100

Table 2: Symptomology

Symptoms	No. of Cases	Percentage
Scrotal swelling	42	36.5
Scrotal pain	26	22.6
Fever	16	13.9
Burning & frequency of micturition	13	11.3
Pain in abdomen	5	4.34
Infertility	11	9.56
Absent testes (one or both sides)	2	1.73

Table 3: Clinical signs

Clinical Signs	No. of cases	Percentage
Positive transillumination test	18	26.2
Fluctuation	11	15.9
Reducibility	4	5.7
Thrill on coughing	3	4.3
Expansile impulse on coughing	3	4.3
Localisedepididymal swelling	12	17.3
Absent testicular sensations	2	2.8
Tenderness of scrotal swelling	13	18.8
Abdominal lump	2	2.8
Enlarged superaclavicular lymph nodes	1	1.4

Table 4: Pathological Nature

	No. of Cases	Percentage
1. Fluid collection in tunica vaginalis		
a) Hydrocele	21	26.5
b) Hematocele	2	2.5
c) Lymphocele	1	1.26
2. Acute inflammation	9	11.3
3. Chronic inflammation	11	13.9
4. Torsion testes	2	2.5
5. Malpositioned testes	4	5.06
6. Testicular tumours	5	6.3
7. Testicular trauma	3	3.7
8. Testicular &Epididymal cysts	7	8.86
9. Testicular atrophy	5	6.3
10. Varicoceles	8	10.12
11. Testicular microlithiasis	1	1.26
12. Hernias		
a) Omentoceles	0	0
b) Enteroceles	0	0
13. Scrotal wall edema	0	0

***Some of the patients had more than one lesion**

Table 5: Sonographic features Testicular Tumors (n = 5)

Sonographic features	NSGCT (n=2)	Seminoma (n=1)	Terato-Ca (n=1)	Leukemia (n=1)
TESTES				
1.SIZE				
▪ Normal	--	--	1	1
▪ Enlarged	2	1	--	--
2.INVOLVEMENT				
▪ Focal	--	--	1	--
▪ Diffuse	2	1	--	1
3. ECHOTEXTURE	Heterogeous: cystic & hyper echoic areas	Relatively homogenous: cystic areas on HRS	Hypoechoic	Hypoechoic
4. TUNICA INVASION	2	1	--	--
5. CALCIFICATION	--		--	--
▪ Present	2	--	1	1
▪ Absent		1	microlith	
6. CONTRALATERAL TESTES	normal	Normal	Test.microl-ithiasis	Normal

ADNEXAL STRUCTURES 1. EPIDIDYMIS 2. SPERMATIC CORD	 Thickened (n=2) Thickened (n=2)	 Normal Normal	 Normal Normal	 Normal Normal
HYDROCELE	Minimal (n=2) Septated (n=1)	Minimal Septated	Minimal Anechoic	Absent

Table 6: Associated findings in case of Testicular Tumors

FEATURES	NSGCT	Seminoma	TeratoCa	Leukemia	Azzo. Tm
LYMPH NODES • SITE -- paraaortic --peripancreatic --periportal --IIiac • SIZE	 2 2 1 1 Bulky (>6cm) confluent	 1 0 0 0 Bulky (>6cm) confluent	 1 1 1 1 Large discrete	 0 0 0 0 --	 0 0 0 0 --
LIVER METASTASES	1	--	--	--	--
LUNG METASTASES	1	--	--	--	--
HYDROURETERO-NEPHROSIS	2	--	--	--	--

Table 7: CDFI and PD features of Testicular Tumors (n = 5)

FEATURES	NSGCT	Seminoma	TeratoCa	Leukemia
1. SIZE OF LESION ▪ Less than 1.6 cm ▪ More than 1.6 cm	 -- 2	 -- 1	 1 --	 -- 1
2. CDFI FINDINGS ▪ Grade 0—no flow ▪ Grade 1—spotty flow ▪ Grade 2—multiple scattered flow ▪ Grade 3—continuous Flow	 -- -- 1 1	 -- -- -- 1	 1 -- -- --	 1 -- -- --
3. PD FINDINGS ▪ Grade 0—no flow ▪ Grade 1—spotty flow ▪ Grade 2—multiple scattered flow ▪ Grade 3—continuous Flow	 -- -- 1 1	 -- -- -- 1	 -- 1 -- --	 -- -- -- 1
4. PATTERN OF FLOW	Unevenly distributed vessels	Unevenly distributed vessels	--	Evenly distributed vessels
5. SPECTRAL ANALYSIS ▪ PSV > 19.8 cm/sec ▪ Ri< 0.7	 2 2	 1 1	 -- --	 -- 1

Table 8: Sonographic features in Acute Inflammations (n = 9)

Site and features	No. of cases	Percentage
TESTES:		
I. SIZE		
-Increased	5	55.5
-Normal	3	33.3
-Decreased	1	11.1
II. INVOLVEMENT PATTERN		
-Focal	2	22.2
-Diffuse	6	66.6
III. ECHOTEXTURE		
-Hyphoechoic	3	33.3
-Hyperechoic	0	0
-heterogenous	1	11.1
-Normal	5	55.5
EPIDIDYMIS:		
I. SIZE		

-Normal	1	11.1
-Increased	8	88.8
II. INVOLVEMENT PATTERN		
-Focal		
.Head	6	66.6
.Body	0	0
.Tail	0	0
-Diffuse	2	22.2
III. ECHOTEXTURE		
-Hyphoechoic	5	55.5
-Hyperechoic	2	22.2
-Heterogenous	1	11.1
-Normal	21	11.1
SPERMATIC CORD:		
I. SIZE		
-Normal	6	66.6
-Increased	3	33.3
II. ECHOTEXTURE		
-Hypoechoic	1	11.1
-Hyperechoic	2	22.2
-Normal	6	66.6
PERITESTICULAR FLUID:		
I. AMOUNT		
-Absent	5	55.5
-Minimal	1	11.1
-Moderate	3	33.3
-Large	0	0
II. ECHOTEXTURE		
-Anechoic	3	33.3
-Low level echoes	2	22.2
-Echogenic with septations	1	11.1

Table 9: CDFI and PD features in Acute Inflammations (n = 9)

CDFI And PD Features	No. of cases	Percentage
Testicular and Intra-testicular Vessels		
CDFI :		
• Grade 0: No flow	0	0
• Grade 1: Spotty flow	1	11.1
• Grade 2: Scattered flow	5	55.5
• Grade 3: Continuous flow	3	33.3
POWER DOPPLER :		
• Grade 0: No flow	0	0
• Grade 1: Spotty flow	2	22.2
• Grade 2: Scattered flow	1	11.1
• Grade 3: Continuous flow	6	66.6
SPECTRAL ANALYSIS :		
• PSV > 15 cm/sec	4	44.4
• RI less than 0.7	5	55.5
Epididymal Vessels		
CDFI :		
• Grade 0: No flow	1	11.1
• Grade 1: Spotty flow	1	11.1
• Grade 2: Scattered flow	4	44.4
• Grade 3: Continuous flow	3	33.3
POWER DOPPLER:		
• Grade 0: No flow	1	11.1
• Grade 1: Spotty flow	1	11.1
• Grade 2: Scattered flow	4	44.4
• Grade 3: Continuous flow	3	33.3
SPECTRAL ANALYSIS :		
• PSV > 15 cm/sec	6	66.6
• RI less than 0.7	5	55.5

DISCUSSION

The study was carried out among 55 patients voluntarily consenting tobe a part of the study. These patients were were diagnosed with scrotal lesionsfrom clinical examination with no known further severe complications andwere being referred to the Department of Radio diagnosis, Saraswati Instituteof Medical Sciences and Hospital, Hapur (Uttar Pradesh).

The present study was under taken to evaluate the role of highresolution Sonography, CDFI and PD in the evaluation of scrotal pathology. Atotal of 55

patients with scrotal lesions were included in the study.

The youngest patient in this study was 3 months of age and the oldest was 72 years. Majority of patient were between 21 to 40 years of age and the predominant group in the study was 21 to 30 years comprising of 20 patients(37%).

The commonest presenting complaint was that of scrotal swelling in36.5% followed by scrotal pain in (22.6%) patients. Positive trans-illumination suggestive of fluid collection of positive in 18 patients (26.2%) while tenderness of scrotal swelling was noted in 13 patients (18.8%), testicular tumor in 3cases, torsion of testes in 2 cases, malposition testes in 4 cases, testicular trauma in 3 cases, testicular and epididymal cysts in 7 cases, varicocele in 8 cases and the rest were miscellaneous lesions including testicular atrophy, testicular microlithiasis, hernia and scrotal wall thickening.

Out of 55 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 68% and abdominal in 9% cases.

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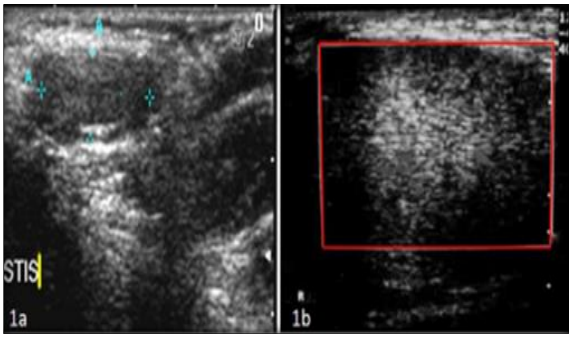

Figure 1: Cryptorchidism and torsion

(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.

On CDFI and PD the vascularity of the underlying testes was maintained in idiopathic hydroceles. However, reduced diastolic flow was noted in some 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.

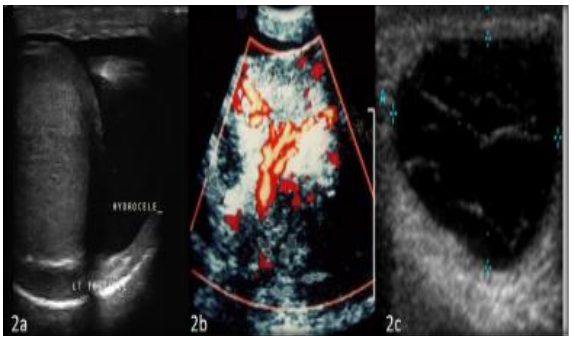

Figure 2: Hydrocele / hematocele / pyocele

(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.

Eight cases of unilateral varicoceles were seen. Of these 7 cases (87%) were noted on left side. Maximum vessel diameter was > 4 mm in 3 cases (37.5%). All cases demonstrated accentuation on Valsalvamaneuver and on assuming erect posture. Color Doppler was found to be more sensitive than clinical examination to detect varicoceles. Grade III reflux on Valsalvamaneuver was noted in 5 cases (62.2%). 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.[6]

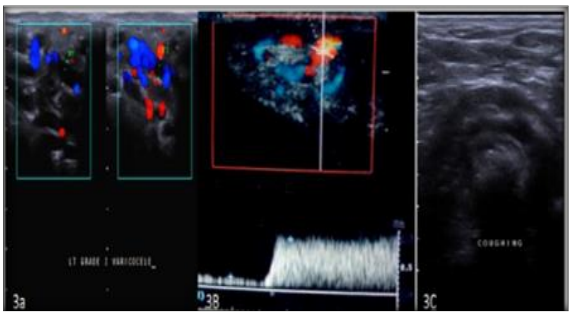

Figure 3: Varicocele and hernia

(a) Grey scale sonography shows multiple dilated anechoic channels are seen in the spermatic cord. Color Doppler during valsalva;Spectral analysis of patient shows venous flow with reflux on

Valsalvamaneuver in varicocele. (b) 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]

Seven cases of spermatoceles and 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 and enteroceleswas seen in few cases. Similar withan 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 Gupta AK et al.[13] Hollaway had similar observations.[14]

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 66.6% cases with hypo echogenicity in 55.5% of cases. Spermatic cord involvement was less frequent. Some amount of peritesticular fluid was noted in 55% of these cases. Horstman reported the involvement of testes in 20% to 40% of cases with focal involvement in 10% of cases.[15] On CDFI and PD hyper vascularity of involved testes was noted in 66.6% and 88.8% cases, respectively. In epididymis, CDFI demonstrated hyper vascularity in 44% cases while PD showed hyper vascularity in 88%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.[15]

Chronic inflammations including tuberculous epididymoorchits 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.[16-17]The epididymal lesions were hypervascular on CDFI and PD in nearly 70% of cases.

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.[16] 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 some 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 similar findings.[18]

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. Dewire et al,[19] also noted absent vascularity in 25% cases of testicular trauma in their study of four patient.[20]

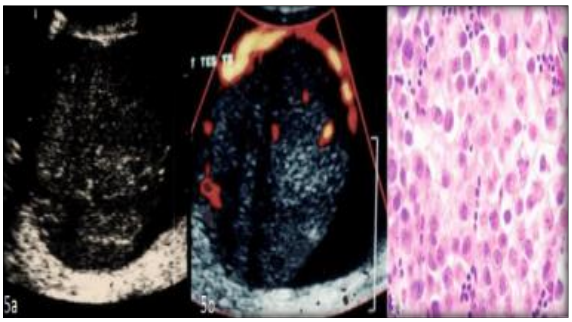

Figure 4: Seminoma

(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

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 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.[24]

The focal hypo echoic lesion was noted in the case of teratocarcinoma. 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. 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 2 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. 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]

Limitations of the Study

- A research group of 55 individuals may not be diagnostically sufficientfor concluding such evidences. A larger sample size with preferably acohort-based periodical evaluation would be more helpful
- Other radiological and diagnostic parameters, particularly related toscrotal abnormalities and torsion would also have been helpful injudging the status of the chronic co-morbidity.
- Most of the clinical parameters are a superficial estimate of thecondition, however, a repeated analysis of the parameters should bedone for proper assessment

CONCLUSION

The various parameters in scrotal diseases have been studied andevaluated sonographically (gray-scale, CDFI and PD) in the background of
clinical and laboratory data.

On the basis of this study, the following conclusions were arrived at:

- Scrotal diseases were seen in all age groups with predominance inyoung males.
- Scrotal swellings followed by scrotal pain were the commonest clinicalsymptoms.
- 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.
- Sonography was useful in localizing scrotal abnormally as intratesticular 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 diagnosis of hydrocele. Furthermore, it helped in evaluating the integrity and size of testes incases associated with large hydrocele, which is difficult clinically.Sonography could distinguish idiopathic hydrocele from that followingtrauma, infections and lymphatic obstruction
- Inflammatory scrotal pathologies were diagnosed easily by high-resolution sonography with high accuracy. The extent of testicular andepididymal involvement was reliably detected as was the presence ofany associated fluid collections.
- Sonography is an ideal tool for detection of testicular tumors as provedin this study with a sensitivity of 100%.
- High resolution was 100% sensitive in detection and localization of scrotal masses.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 spermatoceleswere diagnosed with high accuracy. Although the two conditions couldnot be differentiated from each other based on sonographic findings.
- In case of scrotal hernias, the hernial contents were well evaluated bysonography. Bowel 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 weremore than 1.6 cm were hyper-vascular and those less than 1.6 cm were hypo-vascular. 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 sensitivethan CDFI to compare the involved side with contra lateral normal side,especially in pre-pubertal males.

- CDFI and PD accurately detected the vascular status of undescendedtestes especially in pre-pubertal males.
- 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.
- CDFI was found to be very sensitive in detecting testicular ischemia incases of significant scrotal trauma.

Varicoceles were accurately diagnosed using CDFI and PD.

The present study concludes that high-resolution sonography along with color Doppler flow imaging (CDFI) and power Doppler (PD) should be used asfirst-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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