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Original Article

# Role of Ultrasonography and Colour Doppler in Evaluation of Scrotal Pathologies

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## ABSTRACT

**Introduction**: The Scrotum is a cutaneous pouch which contains the testes and parts of the spermatic cords. Though scrotum is accessible for clinical examination, it is difficult to differentiate benign and malignant swellings and intra testicular from extra testicular swellings, particularly in hydrocele or in cases associated with tenderness.
**Materials And Methods:** This Prospective Observational Study Conducted in the Department of Radiodiagnosis, NRI Institute of Medical Sciences, Visakhapatnam, Andhra Pradesh, India from the period of January 2025 to January 2026 A total of 104 patients from all age groups with signs and symptoms related to scrotal diseases have been included in this study.
**Results**: A total of 104 patients from all age group with signs and symptoms related to scrotal pathologies were evaluated using grey scale sonography and color Doppler flow imaging.
**Conclusion**: In present study about 104 cases were studied with ultrasonography and Colour Doppler flow imaging.

***Keywords***: *Scrotal Pathologies, Ultrasonography, Color Doppler Imaging, Testicular Disorders, Scrotal Swelling.*

## INTRODUCTION

The Scrotum is a cutaneous pouch which contains the testes and parts of the spermatic cords. Though scrotum is accessible for clinical examination, it is difficult to differentiate benign and malignant swellings and intra testicular from extra testicular swellings, particularly in hydrocele or in cases associated with tenderness.

In the clinical examination of the scrotal swelling, physical evaluation by itself may be inadequate due to tenderness, swelling or gross distortion of scrotal contents. Routine clinical examination may overlook significant pathology and physical signs elicited may be improperly interpreted. Clinical signs and symptoms are often nonspecific, variable and misleading. The acute scrotum is a clinical picture of sudden-onset scrotal pain, redness, and swelling, most frequently caused by acute epididymo orchitis, torsion of the testicular appendages, or testicular torsion, differentiation of these conditions is necessary for determining appropriate treatment.

Various imaging modalities have been tentatively used to complement the physical findings and clinical presentation in the differential diagnosis of scrotal pathology. The present day diagnostic armamentarium includes grey scale ultrasonography, Doppler studies, computed tomography, magnetic resonance imaging, radioisotope studies and testicular angiography.

In 1974, Miskin and Bain first reported the use of B mode ultrasound to examine the testis and scrotum [1]. grey scale sonography is currently the primary imaging modality for the assessment of scrotal disease [2], reasons for its increased use include no ionizing radiation, non invasive, speed of examination and superior resolution of solid lesion and cystic/fluid collection.

High-resolution sonography provides excellent anatomic detail of the scrotal wall, testis and epididymis; when colour Doppler and power Doppler imaging are added, testicular perfusion can be assessed [3].

The role of computed tomography in the assessment of testicular pathology has been diminished with the advent of MRI due to its radiation effect. The computed tomography is useful for evaluation of cryptorchidism, staging of testicular malignancy and detection of retroperitoneal lymphadenopathy.

Magnetic resonance imaging [4] has emerged as a powerful tool to image scrotum as it is a non ionizing technique, capable of multiplanar imaging and flow displays. Its wide field of view allows simultaneous assessment of both hemiscrotal contents and inguinal region, offering a distinct advantage over ultrasound. Its high contrast and spatial resolution allows differentiation of testis, epididymis and spermatic cord. However magnetic resonance imaging is expensive and not readily available.

The present study, "Role of ultrasonography and colour doppler in evaluation of scrotal pathologies" was undertaken to correlate the clinical findings with grey scale sonography and colour Doppler flow imaging, in various scrotal pathologies and to use this multifold data to reduce diagnostic difficulty.

**AIMS AND OBJECTIVES**

- To differentiate scrotal lesions into testicular and extra testicular pathology.
- To evaluate imaging features & efficacy of grey scale sonography in spectrum of scrotal pathologies.
- To evaluate colour Doppler flow imaging features of scrotal pathologies.
- To correlate sonographic features of various scrotal pathologies with clinical findings.

**ULTRA SOUND FEATURES OF SCROTAL AND TESTICULAR PATHOLOGIES:**

**A. Congenital lesions:**

**i. Testicular:**

**Cryptorchidism and Incomplete descent:**

The term cryptorchidism (undescended testis) refers to those testes, which are truely obscure, lying usually within the abdominal cavity and not palpable on examination. Testes lying in the course of normal descent in inguinal canal are usually palpable and are termed incompletely descended testes. Etiology: Low birth weight, pre maturity, small for date infants, twin neonates. Undescended testis is one of the most common genitourinary anomalies in male infants. The prevalence of undescended testis is 3.5% at birth; this rate decreases to 0.8% by 1 year because, in many patients, the testes descend spontaneously. The prevalence is higher in premature neonates (it is virtually 100% in neonates who weigh less than 1 kg at birth).

High frequency ultrasonography has a limited role in management of undescended testis. Ultrasonography may disclose a mass in the expected position whose echogenicity is less than that of the surrounding fat. To prove that a mass is testis, one must identify a bright echogenic band, the mediastinum testis; this is necessary because a large lymphnode can simulate an undescended testis, but lacks this structure.

In incomplete descent, the testis is arrested at some point in its normal course of descent at or below the level of internal inguinal ring. Usual site of arrest are, deep inguinal ring, inguinal canal, superficial inguinal ring. Usually there will be associated congenital indirect inguinal hernia, due to non-obliteration of processus vaginalis, as well as occurrence of congenital hydroceles.

**Incidence:**

Right testis alone is affected-----50 %
Left testis alone is affected ------30 %
Both testes effected ------20 %

High frequency ultrasonographic appearance: The incompletely descended testis may be located along the path of testicular descent after its exit from the deep inguinal ring. The incompletely descended gland will be smaller and will have a

homogenous hypoechogenicity, compared to normally descended testis. Identification of the mediastinum testis may be possible in some cases [18-23].

In 1996 Cain et al [24], evaluated 64 young patients( with 74 non palpable testes) during a period of 4 years with pre-operative scroto-inguinal ultasound and surgical exploration. Diagnostic laparoscopy was reserved for patients with negative ultrasound and no palpable tissue in the scrotum or groin at the time of examination. They found that ultrasound correctly identified 40 of the 42 inguinal testes, 7 of the 21 atrophic inguinal testes and 1 of the 11 intra-abdominal testes. They thus inferred that scroto-inguinal ultrasound identifies patients with non-palpable testis who will maximally benefit from diagnostic laparoscopy.

**ii. Scrotal**

**Congenital hydroceles**

Hydrocele is an abnormal extratesticular fluid collection, which may be congenital or acquired. Congenital hydrocele usually resolve by 1-2 years of age [25] .

**B . Inflammation of scrotum and its contents.**

**i. Acute Epididymitis and Epididymo orchitis:**

Epididymitis and epididymo orchitis are the most common cause of acute scrotal pain. Most cases of epididymitis are caused by retrograde spread of infection from the urethra or urinary bladder [26].

In 1984, Rifkin et al[27] demonstrated the enlargement of epididymis with decreased echogenicity in cases of acute epididymo orchitis.

In 1986, Mevorach et al [28] could demonstrate good correlation between ultrasound and pathological findings in 8 surgically proven cases of testicular abscess. There was gross disruption of testicular architecture with hypoechoic spaces separated by radiating striations of increased echogenicity.

In 1991, Horstmann et al [10] in a study of 51 cases, elaborated the colour Doppler findings of scrotal inflammatory conditions. In all the cases there was evidence of hyperemia in the affected portion, where as the grey scale sonography was normal.

In 1995, Brown et al [29] established the quantitative Doppler criteria for acute unilateral epididymitis and / or orchitis. A PSV equal to or more than 15cm/sec produced diagnostic accuracy of 90% for orchitis and 93% for epididymitis.

In 1997, Jee et al [30] studied resistive index of intrascrotal arteries in normal subjects and in patients with epididymitis and/or orchitis. The resistive index of testicular artery in epididymo-orchitis was significantly lower than those in normal control subjects with cut off value of RI - 0.5, the sensitivity and specificity were 94% each.

In 2000, Farriol et al [31] evaluated the grey scale and power Doppler sonographic appearance in 25 cases of acute inflammatory diseases of the scrotum. They found that in all of the 20 post pubertal cases the power Doppler revealed increased vascularity in the spermatic cord , epididymis or testis while grey scale could show enlargement and heterogenecity of the epididymis and / or testis only in 11 out of 20 cases. In the cases of testicular abscess, power Doppler showed a hyperemic halo surrounding the fluid collection, which contributed to the diagnosis. They concluded that though power Doppler may not be superior to colour Doppler in the diagnosing inflammatory diseases, it is easier and faster to use than colour Doppler in evaluating these diseases.

In 2000, Cook et al [32] reviewed the changes seen on high resolution ultrasound in orchitis and suggested that in orchitis there is edema of the testis contained within an unyielding tunica albuginea, which results in various scales of reflectivity seen as heterogeneity on sonography.

**ii. Chronic Epididymitis and Epididymo orchitis**

As with acute epididymitis and epididymo orchitis, chronic epididymitis and epididymo orchitis, represent a spectrum of inflammatory injury with testicular inflammation arising secondary to epididymal inflammation. However, testicular involvement may occur many years after epididymal disease.

**Classification:**

1. Chronic tuberculous epididymitis / Epididymo orchitis
2. Chronic non-tuberculous epididymitis / Epididymo orchitis [10]

Tuberculous epididymo orchitis occur by retrograde extension from the prostate and seminal vesicles and also from hematogenous dissemination or perivasal lymphatics[33].

In 1986, Gow et al [34] showed tuberculous epididymo orchitis predominantly involves epididymis of one side. They reported an associated orchitis in 14% of their patients.

In 1993, Kim et al [35] performed scrotal sonography in 10 patients with tuberculous epididymitis. They found enlarged epididymis, predominantly in tail portion and marked heterogenicity of the echotexture of involved epididymis. Sonographic findings of associated testicular involvement consisted of a diffusely enlarged hypoechoic testis or ill defined focal intratesticular hypoechoic area, or an irregular margin between the testis and epididymis. The testis, epididymis and tunica vaginalis had areas of calcification occasionally. An enlarged and heterogenous epididymis is reliable in differentiating tuberculous from non-tuberculous epididymitis.

In 1997, Chung et al [36] evaluated 22 patients with tuberculous epididymitis and/or orchitis and concluded that heterogenous and hypoechoic swelling of epididymis, or the concomitant hypoechoic lesion of testis with associated sinus tract or extratesticular calcification may be helpful in the diagnosis of the above condition. Tuberculous orchitis with no epididymal involvement was very rare.

In 2000, Yang et al [37] retrospectively analyzed colour Doppler ultrasound findings in 12 cases of histopathologically proven tuberculous epididymitis and tuberculous epididymo orchitis in 11 consequtive patients. Colour Doppler ultrasound demonstrated no blood flow in the epididymal lesions except for focal linear or spotty flow signals in the peripheral portion which correlated well with pathologic findings of central caseous necrosis and peripheral signal due to small vessels in the periphery.

In 2001, Muttarak et al [38] described three grey scale appearances of tuberculous epididymitis – diffusely enlarged and heterogeneous hypoechoic; diffusely enlarged and homogeneously hypoechoic; and nodular enlarged and heterogeneously hypoechoic.

**iii. Complications of inflammatory disease of testis and epididymis:**
Abscess formation (testicular, epididymal), pyocele, scrotal wall abscess, funiculitis, hydrocele formation and testicular ischemia (due to compression of testicular veins by the cord oedema) .

In 2001, Yang et al[39] retrospectively compared the clinical, grey scale and colour Doppler sonographic features in 10 cases of tuberculous epididymal abscess and 13 cases of pyogenic epididymal abscess. They found that tuberculous abscess had a longer duration of symptoms, was larger in size and had lower degree of flow in the peripheral portion of the abscess. The patient's age, location and echogenicity of the abscess, presence of sinus tract, hyperechoic rim, testicular involvement and hydrocele did not differ between the tuberculous and pyogenic epididymal abscesses.

Pyocele forms due to rupture of a testicular or epididymal abscess into the tunical sac. On scan, pyocele appears as a loculated fluid collection with multiple internal echoes; fluid-fluid and fluid-debris levels may be seen. The presence of gas in the tunical sac may be identified as a strong reflector with posterior comet tail artifacts. No flow is seen on colour Doppler scan [40].

**iv. Scrotal wall inflammatory diseases:**
**a. Cellulitis of scrotal wall:**
Normal scrotal wall thickness is 2 -8 mm. Scrotal wall oedema occurs secondary to acute epididymitis and epididymo-orchitis; however, it also occurs primarily in a number of conditions like, cellulitis of scrotal wall, Fournier's gangrene. On high frequency US scan shows, cellulitis of scrotal wall manifests as thickening of scrotal wall, loss of uniform hyperechogenicity of scrotal wall and testis and epididymis will be normal [41].

**b. Fournier's gangrene :**
This is a rapidly progressive fulminant acute fascitis involving scrotum and perineum. It is associated with a high mortality (33-35%). High frequency ultrasound scan shows scrotal wall thickening, loss of normal hyperechogenicity of the scrotal wall (Loss of homogenous band like appearance of wall). The hyperechoic band like region is replaced by multiple varying echogenicity. The fluid accumulation occurs in the connective tissue layer between the dartos and cremasteric fascia and this layer appears hypo echoic on ultrasound [41,42].

**C. Non inflammatory swellings of scrotum.**
- **I. Neoplastic.**
- **II. Non-neoplastic**

**I. Neoplastic swellings of Scrotum:**
- **a. Testicular Neoplasms:**

Testicular tumors represent only 1% to 2% of malignant tumours in men, but they are most common malignancies in the 15-35 year age [43] .

Ninety-five percent of primary testicular neoplasms are of germ cell origin. The incidence of testicular germ cell neoplasm is 2 per 100000. These are seminoma (40-50%), embryonal carcinoma (15-20%), teratoma (5-10%), choriocarcinoma(rare). Remaining five percent neoplasms arise from Sertoli cells, Leydig cells or mesenchymal tissues.

Secondary neoplasms include reticuloendothelial neoplasms like lymphoma, leukemia. Testicular metastases may arise from a variety of primary cancers, most commonly from lung carcinoma , primary from GIT tumours, prostatic carcinoma, melanoma, sarcoma, renal cell carcinoma.

The testicular tumours have a trimodal age distribution with peak during infancy, late adolescence and early adulthood and after 60 years of age.

Etiological factors include undescended testis, orchitis (past history of mumps orchitis or other forms of orchitis), trauma (it is postulated that trauma directs medical attention to the silent tumour and is not directly causative), genetic factors [44,45].

Earliest imaging of testicular tumors by sonography was performed by Miskin and Bain [1] in 1977. They saw a neoplasm as a cluster of echoes or internal echoes with irregular pattern.

Ultrasound has been reported to have a relatively high sensitivity for detecting testicular tumours; 100% in a series by Benson et al [46] and 95% by Geraghty et al [47].

**Seminoma:**
Seminoma occurs in the age group 30-40 years. Pure seminomas are characterized by smooth or irregular marginated, homogenously hypoechoic lesions without calcification. Cystic areas are rare and if present, small multifocal involvement may be seen[48,49] .

**Embryonal carcinoma:**
Embryonal cell carcinomas are most aggressive and may show features of local invasion as infiltrating through tunica albuginea into epididymis. On high frequency US scan, these tumours show echogenic foci occurring with or without distal shadowing are found in up to 40 % of cases. 1/3$^{rd}$ of these neoplasms also show cystic components. Pure embryonal carcinoma is rare and commonly mixed tumours are seen (associated with teratoma) [48,49] .

**Teratoma:**
On High frequency US scan these appears as markedly heterogenous lesions with multiple cystic areas. Bright echogenic foci with distal acoustic shadowing represents immature bone elements or without distal shadowing representing fibrous connective tissue elements and hair are observed [48,49].

**Choriocarcinoma:**
This is a highly aggressive tumour prone to hematogenous metastasis, unlike other testicular tumours, which spread mainly by lymphatic routes. Areas of necrosis and cystic changes are noted in the primary tumour. Due to its aggressive nature, the primary tumour may outgrow its blood supply and regress in the presence of widespread metastases. This phenomenon is termed as “burned out tumour”. The regressed tumour may appear as a calcified or echogenic fibrous scar [48, 49].

**Mixed germ cell tumour:**
Up to 40% of germ cell tumours are made up of more than one germ cell type except for spermatocytic seminoma, which tends to occur only as pure tumour. All other tumours show mixed cell elements. These are heterogenous on US with cystic areas frequently noted [48, 49].

**Tumours from non-germinal epithelium:**
Non germ cell tumours are generally benign, but they produce hormones such as estrogens and androgens leading to endocrine syndromes. They include Leydig cell tumours, Sertoli cell tumours, and mesenchymal cell tumours. They can occur at any age. The Leydig cell tumour is associated with excess androgen production; it may be associated with sexual precocity and extreme muscularity [Infant Hercules]. The Sertoli cell tumours cause excessive estrogen secretion leading to gynecomastia, loss of libido. About 10 % of these stromal tumours may turn malignant [48, 49].

**Secondary neoplasms:**
**Reticulo endothelial tumours :**
**Testicular lymphoma and leukemia:**
Testicular lymphoma is the most common primary and secondary testicular neoplasm in men aged 60 to 80 years. Testicular lymphoma constitutes 1-7 % of all testicular tumours. The primary lymphoma in which the tumor mass is confined to testis at time of clinical onset is rare. It is in 1 % of all cases of non-testicular lymphomas and 5% of Burkitt’s lymphoma. It is practically non-existent with Hodgkin’s lymphoma. Involvement is usually unilateral. Leukemic involvement of testis is most often seen in childhood, and rarely clinically evident in adults. On high frequency US imaging, both lymphoma and

leukemia appear either as, diffuse homogenously hypoechoic testis or focal hypoechoic areas with an enlarged testis. The differential diagnosis for leukemia and lymphoma will be orchitis, infarction and multifocal germ cell tumour [50, 51] .

**Metastases:**
Metastatic carcinoma of testes, excluding leukemia and lymphoma is an extremely rare but interesting phenomenon. The first case reported by Creeny in 1935, of RCC metastasizing to testis. Pathologically the testicular metastases have been described as focal nodules, more commonly located in the epididymis or diffuse involvement of interstium of testes, with relative sparing of seminiferous tubules.

Putative routes postulated are vas deference for prostatic carcinoma, lymphatics for GIT, spermatic veins for renal cell carcinoma, and hematogeneous [arterial remobilization] for bronchogenic carcinoma.

The US appearance is similar to that of a primary germ cell tumour, manifesting as a small, hypoechoic region within the testicular substance. This pattern of a focal nodule is more common in the epididymis than the testes. Testicular involvement is also seen in the form of a diffuse involvement. Bilateral involvement is noted in 40 % of cases[52].

**b. Epididymal neoplasms:**
Epididymal neoplasms include adenomatoid tumours (Mesothelioma), mesenchymal neoplasms, cystadenoma of epididymis, and metastasis.

Adenomatoid tumours are rare, slowly growing benign neoplasm, which represents 30% of all extra testicular neoplasms; most are epididymal. They arise after the age of 20 years, are usually unilateral, and show presence of associated hydroceles in 15 – 20% cases. Clinically they are usually asymptomatic, but 30 % of cases present with scrotal pain. Histologically these tumours are derived from mesothelial origin, hence they are also known by the term –mesothelioma.

Other neoplasms involving the epididymis are leiomyoma and papillary cystadenoma. Cystadenoma of epididymis, which is rare, are often a part of Von-Hippel-Lindau syndrome and usually have a cystic component. They are bilateral in 33 % of cases. On high frequency US they appear hyperechoic, homogenous and well circumscribed[53, 54, 55, 56] .

**c. Spermatic cord neoplasms:**
Lipoma, leiomyoma, neurofibroma and embryonal rhabdomyosarcoma are known to occur in spermatic cord . Lipoma of the cord is the most common tumour. Leiomyoma and neurofibroma occurs less frequently. Malignant tumours are chiefly sarcomas, in first three decades of life, these are almost invariably embryonal rhabdomyosarcoma. On high frequency US the lipoma appear as a well-circumscribed lesion with medium to low intensity echoes, confined to the cord and discrete from both testes and epididymis [57].

**II. Non-inflammatory, Non-neoplastic swellings of scrotum:**
**Hydrocele :**
Hydrocele is an abnormal extratesticular fluid collection, which may be congenital or acquired. Acquired hydrocele may be idiopathic or may occur secondary to epididymitis, trauma, torsion or testicular tumours [58].

Large hydrocele clinically may cause testis impalpable and in these cases ultrasound is of great value in assessment of the testis. Sonologically hydrocele seen as anechoic collection with good sound transmission. Occasionally, there can be internal echoes or hyperechoic fluid which is related to the presence of cholesterol crystals in the hydrocele fluid [59].

**Epididymal cyst:**
They occur in approximately 30 % of the general population. They are typically small and unilocular. Most arise in the epididymal head, although they can occur in the body and tail. Epididymal cysts may be observed in association with tubular ectasia of the rete testis [3, 55].

**Spermatocele:**
This is retention cyst arising from some portion of sperm conducting tubules of the epididymis. It is usually situated in the epididymal head and hence is above and behind the testis. Spermatoceles tend to be larger and multiloculated and are also located predominantly in the region of epididymal head .

Both lesions fulfill sonographic criteria for cysts, appearing anechoic. It is difficult to distinguish cysts and spermatoceles on US. Large spermatocele tend to displace the testis anteriorly and may be septated. Spermatoceles may show evidence of fluid-fluid levels [3, 15, 60].

**Testicular cysts:**
These are of two types. Tunica albugenia cysts and intra testicular cysts. Recent reports suggest an incidence of 5 -10 % in the general population. Tunica albugenia cysts lie outside the parenchyma of testis on the surface. They are thought to be either dilated blind ending efferent tubules or Mullerian / mesonephric duct remnants. They may also occur secondary to

inflammation or trauma. They are small in size (2-5 mm) and located peripherally. Clinically patients are asymptomatic and usually in their 4th or 5th decade. They may be palpable. On high frequency US they appear as simple cysts with smooth contours, thin wall, anechoic contents and posterior acoustic enhancement proportional to cyst size. Intratesticular cysts are nonpalpable. These are usually located in the region of mediastinum. They probably originate from the rete testis. They are thought to be secondary to prior inflammation or trauma. Intra testicular cysts are non-palpable and are diagnosed by ultrasonography. They appear as simple cysts surrounded by normal testicular parenchyma. Complicated cysts show irregular borders, thick wall, mural nodule, calcification - suggesting the possibility of malignancy [15, 60].

**Varicocele:**
Varicocele is defined as an abnormal dilatation and tortuosity of veins of pampiniform plexus. It occurs in 15 – 20 % of general population, and in 21-39 % of men attending infertility clinics. Pathologically, varicoceles may be either,

- -Primary or idiopathic.
- -Secondary.

**Primary varicoceles** arise through the following mechanisms,

- Incompetent internal spermatic vein (testicular vein) valves, leading to reflux.
- Collaterals bypassing competent valves.
- Absent valves.

The relationship between varicocele and male subfertility has been recognized since the late 19th century. Patients with varicocele exhibit decreased sperm counts, decreased sperm motility, and increased number of abnormal morphology.

**Secondary varicoceles** are due to extrinsic compression of gonadal veins by nodes, neoplasms and hydronephrosis. Obstruction of left testicular vein by renal vein thrombosis as in tumour thrombus.

**The role of high frequency US in Varicocele is two folds.**

- Diagnosing varicocele
- Assessment of treatment results.

**Technique:** Scanning is done in both supine and standing positions. It is recommended that patients stand for at least 2 minutes prior to evaluation in the standing position. Subjects are instructed to perform the Valsalva maneuver. The diameter of the dominant vein is compared prior to and during performance of the Valsalva maneuver. Abdominal US is done routinely, on all patients in whom a varicocele is detected on high frequency US scrotal scan, to evaluate for a secondary cause for varicoceles, such as renal vein thrombosis.

**High frequency US and colour Doppler ultrasound scan appearance:**
The varicocele appears as numerous dilated anechoic tubular / serpingenous structures situated posterior to the testes, in the spermatic cord, in the neck of scrotum and in the inguinal canal.

A varicocele is considered present, by gray-scale evaluation if 2 or more veins are present, with at least one vein having diameter of 3 mm or more and on colour Doppler sonography if retrograde flow is identified within the pampiniform plexus spontaneously and / or during Valsalva maneuver. In normal subjects, this increase in diameter is of the order of 0.5 mm or less.

**Ruben Orda et al have sonologically graded varicoceles, based on venous diameter of the main spermatic vein.**

1. **Small varicocele:** Mean diameter 3 – 4 mm in relaxed standing position / 1mm increase on Valsalva maneuver.
2. **Moderate Varicocele:** Mean diameter is 4 - 5 mm / 1.2 mm to 1.5 mm diameter increase on Valsalva maneuver.
3. **Large varicocele:** Mean diameter of dominant vein is 5 mm / more than 1.5 mm increase on Valsalva maneuver [61, 62, 63, 64].

**Intra testicular Varicocele:**
This is an extremely rare condition characterized by dilated intra testicular veins in association with an ipsilateral extra testicular varicocele. These structures are distinguished from transmediastinal vessels by their serpingenous course within the substance of testis. Like transmediastinal vessels, they are situated near the mediastinum testis. On performing Valsalva maneuver, these vascular structures become more prominent. Intra testicular varicocele can be closely mimicked by tubular ectasia of the rete testis. Differentiation is made on the basis of colour Doppler findings showing venous flow in intratesticular varicocele and by provocative technique i.e. Valsalva maneuver [63].

**Inguinal hernia:**
Inguino-scrotal hernias are classified into direct and indirect types. An indirect hernia leaves the abdominal cavity at the internal ring, traverses through the inguinal canal, and if complete – extends up to the inferior aspect of scrotal sac. A direct hernia protrudes forward through the Hesselbach's triangle and may extend into the scrotum via superficial ring. Diagnosis

is made based on history and careful clinical examination. Occasionally however, scrotal hernias may present as firm nontransluminent, non-reducible masses mimicking primary scrotal pathology. These manifests clinically as pain in the groin or referred to the testicle, expansile impulse on coughing and reducibility in uncomplicated cases. The sonographic criteria to reliably differentiate scrotal hernia from primary scrotal pathology are, Identification of loops of bowel within the scrotum, exclusion of testicular pathology by demonstrating normal testicular elements, Presence of hernial sac in the inguinal region containing bowel and/or omentum [3, 7].

**D. Scrotal and testicular injury:**

Injuries to the scrotum may result from blunt (85%) or penetrating (15%) trauma. Testicular rupture is a surgical emergency, because surgical intervention before 72 hours salvages more than 80% of affected testis. It is seen as focal alteration of testicular echogenicity correlating with areas of intratesticular hemorrhage or infarction [65].

Kratzik et al [66] described the sonographic features of intratesticular hematomas in their study of 44 patients with blunt testicular trauma. They observed that the normal ovoid shape of the testis was preserved. However an irregular hypoechoic mass or stellate hypoechoic areas were seen within the region of hemorrhage.

**E. Miscellaneous Scrotal pathologies.**

**Scrotal calculi and Calcification:**

Calcific loose bodies are unusual, seen between the membranes of the tunica vaginalis. These are usually round, pearly white, rubbery and microscopically rich in fibrinoid material deposited around the central nucleus of hydroxyapatite. On sonography, they are identified as mobile echogenic foci located within a fluid filled tunical sac with characteristic acoustic shadowing.

**The causes for scrotal calcification are:**

- Calcification of detached testicular appendix epididymis after torsion of these appendages.
- Desquamated fibrinoid debris within hydrocele fluid.
- Calcified sperm granuloma
- Calcifications within testicular tumours.
- Epididymal calcifications.
- Phleboliths.
- Calcified hematocele, pyocele or hydrocele wall.
- Extensive scrotal wall hematoma calcification.

It may be intratesticular or extra testicular. Different types of calcifications are described. Solitary punctate intratesticular calcific foci, with or without acoustic shadowing – represent phleboliths or spermatic granuloma. A cluster of punctate foci may identify vascular calcification within the testicular parenchyma. A cluster of calcification, seen in association with a hypoechoic area suggests a testicular tumour or chronic testicular infarction. Focal infarction is usually peripheral and wedge-shaped, with linear edges containing specks of calcification representing areas of necrosis.Most germ cell tumors which appear as hypoechoic lesions with varying degree of heterogenicity, shows calcifications but its presence and distribution does not reflect a specific cell type [67].

**Testicular microlithiasis:**

This is a rare condition with prevalence of 0.05 – 0.6 %. Testicular microlithiasis consists pathologically, of intra tubular intratesticular calcification. Histologically, degenerative cellular debris within the semineferous tubules forms the nidus for dystrophic calcification. The main clinical significance lies in the fact that 40 % of testicular microlithiasis cases have an associated germ cell tumour.

**Testicular microlithiasis has been associated with the following diseases:**

Testicular germ cell neoplasms, cryptorchidism and undescended testis, Klinefelter syndrome, male pseudohermaphroditism, Down's syndrome, pulmonary alveolar microlithiasis. The sonographic appearance of testicular microlithiasis is characteristic. Numerous tiny hyperechoic foci, measuring less than 2 mm in diameter are present diffuse throughout both testes. Acoustic shadowing is not seen probably due to the small size of the calcifications. Testicular microlithiasis is almost invariably bilateral.

Testicular microlithiasis is of 2 types, depending on the number of echogenic foci per image. With 5 or more echogenic foci on a single image called as classic testicular microlithiasis, with fewer than 5 echogenic foci is called as limited testicular microlithiasis category. It is recommended for annual US follow-up for several years after the diagnosis, since associations with testicular neoplasia has reported [68, 69, 70].

**Scrotal Filariasis**

The "Filarial dance sign" is described on high resolution ultrasound shown as linear echogenic structures with persistent, random, almost tireless twirling movements of live adult filarial worms in the lymphatic vessels. Pulse wave Doppler reveals worm nests, in enlarged lymphatic vessels by the characteristic pattern of irregular worm movements, in colour

Doppler visualized in form of an irregular red colour signal. US shows dilatation in the lymphatic vessels, early and advanced stages of hydrocele, and the number of worm nests over time. On follow-up US, after the treatment with DEC, complete absence of worm movements was taken as a positive response[71, 72] .

**Testicular torsion:**
Testicular torsion occurs when the spermatic cord is twisted and it has been argued that the correct term should be spermatic cord torsion [73].Torsion of the spermatic cord occurs most commonly in 12-18 years of age.

Testicular torsion is divided in to two categories –

**Extravaginal torsion-** in which both the contents of the tunica and the tunica itself rotate, and is seen mainly in neonates. This condition is due to loose attachments of the tunica to the scrotal wall.

**Intravaginal torsion** is the type most commonly associated with older children and adults. Intravaginal torsion is associated with a tunica vaginalis that not only surrounds the testicle and most of the epididymis, as is the normal situation, but also surrounds the spermatic cord allowing free rotation of the structures within the tunica and is seen mainly in adolescents [73].

Sidhu et al [74] reviewed the clinical features and role of CDFI and other imaging modalities in the diagnosis of testicular torsion. They concluded that there is no single clinical feature that can reliably distinguish torsion from other causes of acute testicular pain. They further suggested that CDFI is able to reliably image acute epididymo orchitis but there is no imaging gold standard for spermatic cord torsion and that although CDFI useful for assessment of torsion, But CDFI is not infallible.

Acre et al [75] conducted a study to evaluate the importance of direct spermatic cord imaging in the sonographic diagnosis of acute spermatic cord torsion presenting clinically as testicular torsion. Their study comprised six patients with acute scrotal pain and surgically proved spermatic cord torsion later on. Their study showed rotation of the spermatic cord in symptomatic side in all the patients and concluded rotation of spermatic cord could be regarded as highly reliable and direct sign for the diagnosis of testicular torsion even in those cases where intratesticular flow is present on CDFI in the symptomatic side and thus overall let to the conclusion that rotation of the spermatic cord may be considered as predominant criteria for the assessment of testicular torsion rather than intratesticular flow.

Dogra et al [76] reviewed the sonographic features of testicular torsion. They summarized the grey scale and color Doppler flow imaging findings of testicular torsion as follows-
Grey scale appearance of torsion based on Dogra et al.,

- Just after torsion(viable testis) – normal
- <4-6 hours (with infarction) – testicular swelling, decreased echogenicity.
- >24 hours (missed torsion) - heterogeneous echotexture.
- Acute torsion with hemorrhagic infarction- heterogeneous echotexture.
- Chronic torsion – small hypoechoic testis

**Color Doppler flow imaging patterns in testicular torsion based on Dogra et al.**

- Absent arterial or venous flow.
- Increased RI on the affected side (decreased or reversal diastolic flow).
- Decreased flow velocity.
- Low amplitude flow on symptomatic side.

## MATERIALS AND METHODS

This Prospective Observational Study Conducted in the Department of Radiodiagnosis, NRI Institute of Medical Sciences, Visakhapatnam, Andhra Pradesh, India from the period of January 2025 to January 2026 .A total of 104 patients from all age groups with signs and symptoms related to scrotal diseases have been included in this study.

**Inclusion Criteria:**
Cases of all age groups with clinical manifestations of scrotal diseases.

**Exclusion Criteria:**
All cases with scrotal injury.

**CLINICAL DATA:**
Patient details, relevant clinical history was obtained. Clinical examination was done to assess scrotal contents and if necessary reducibility, fluctuation, and transillumination tests were performed.

**SONOGRAPHY**

**EQUIPMENT**

Sonography of all patients in this study was done using 3 to 12 MHz linear transducer and 2 to 5 MHz convex curved array transducer of Philips AFFINITY 70, GE LOGIQ P10 Ultrasound equipment .

Grey scale sonography and colour Doppler flow imaging of scrotal lesions was usually performed with high frequency linear array transducer. In case of large lesions convex curved array transducer was used. Abdominal sonography was done in conjunction with scrotal scans in relevant cases using convex curved array transducer.

Ethical committee clearance has been obtained to conduct present study.

**TECHNIQUE**

The examination was carried out in a setting that provided adequate privacy to the patients. Scanning was routinely performed in supine position. Scrotum was supported using a towel draped over thighs, and the penis was elevated, covered by drape and held up by the patient.

The scrotum was scanned in longitudinal, transverse and oblique planes of all surfaces. When required examination of spermatic cord and groin region was performed. In cases of varicocele, examination was performed in supine posture, erect posture and with Valsalva maneuver.

Both testes were compared routinely, which helped to detect subtle changes in echotexture. Colour Doppler flow imaging was performed to depict flow in the vessels. Pulsed Doppler spectral analysis was performed when necessary.

Attention was given to set optimal gain, colour Doppler scale and pulse repetition frequency(PRF) to obtain adequate contrast resolution and to detect low flow.

Abdominal scan was performed in cases of testicular tumors and varicoceles paying attention kidneys, liver and retroperitoneal regions.

**Following parameters were evaluated during sonography,**

1) **Scrotal wall thickness** – normal / thickened
2) **Testis:**
   Size: normal / increased / atrophic
   Echotexture: Normal/ Hypoechoic / Hyperechoic / Heterogenous
   Colour flow : Normal /Absent / increased / decreased .
   Spectral study: Normal pattern / increased velocity/ absent flow.
3) **Epididymis :**
   Size: Normal / enlarged
   Echotexture: Hypoechoic / Hyperechoic / Heterogenous
   Colour flow : Normal /absent / increased / decreased.
4) **Spermatic cord:**
   Echotexture: Normal/Hypoechoic / Hyperechoic / Heterogenous.
   Pampiniform plexus: Normal / dilated.
5) **Presence or absence of any collection in scrotal sac.**
6) **Inguino-scrotal regions.**

**CHEST RADIOGRAPH (PAVIEW)**

Radiograph of chest was taken in a case of suspected to be having a testicular tumor in order to look for metastasis and in suspected case of tubercular epididymitis.

**LABORATORY INVESTIGATIONS**

Relevant investigations like total and differential blood count, urine routine/microscopic examination and culture were done. Semen analysis was done in patients with infertility.

Finally, analysis was done correlating clinical findings with sonography and further correlated with surgical and histopathological findings (where ever applicable). Effectiveness of grey scale sonography and CDFI in various scrotal pathologies was evaluated.

**OBSERVATIONS AND RESULTS**

A total of 104 patients from all age group with signs and symptoms related to scrotal pathologies were evaluated using grey scale sonography and color Doppler flow imaging.

The age of these patients ranged from infancy to 70 years.

**Table- 1: AGE DISTRIBUTION**

| S. NO. | AGE (YRS) | NO. OF CASES | PERCENTAGE |
|---|---|---|---|
| 1 | 0-10 | 11 | 10.6 |
| 2 | 11-20 | 14 | 13.5 |
| 3 | 21-30 | 33 | 31.7 |
| 4 | 31-40 | 20 | 19.2 |
| 5 | 41-50 | 18 | 17.3 |
| 6 | 51-60 | 5 | 4.8 |
| 7 | Above 60 | 3 | 2.9 |
| | Total | 104 | |

Maximum number of patients were of age group of 21 to 40 years (50.9%).

**Table- 2: CLINICAL PRESENTATION**

| | No. of cases | Percentage |
|---|---|---|
| **Scrotal Swelling** | 20 | 19.2 |
| **Pain** | 14 | 13.5 |
| **Pain and Scrotal Swelling** | 54 | 51.9 |
| **Infertility** | 9 | 8.7 |
| **Absent testis** | 7 | 6.7 |
| Total | 104 | |

**Table- 3: SPECTRUM OF PATHOLOGIES**

| | No. of cases | Percentage |
|---|---|---|
| **Hydrocele** | 29 | 27.9 |
| **Epididymo orchitis** | 26 | 25.0 |
| **Hernia** | 17 | 16.3 |
| **Varicocele** | 10 | 9.6 |
| **Undescended testis** | 7 | 6.7 |
| **Epididymal cyst** | 7 | 6.7 |
| **Torsion testis** | 6 | 5.8 |
| **Testicular tumors** | 2 | 1.9 |
| **Testicular microlithiasis** | 3 | 2.9 |
| **Scrotal wall cellulitis** | 3 | 2.9 |
| **Scrotal filariasis** | 1 | 1.0 |

**Table- 4: THE SPECTRUM OF HYDROCELE**

| | Right | Left | Bilateral | Total |
|---|---|---|---|---|
| **Primary** | 3 | 6 | 7 | 16 |
| **Secondary** | 4 | 4 | 0 | 8 |
| **Congenital** | 2 | 1 | 0 | 3 |
| **Encysted** | 2 | 0 | 0 | 2 |
| Total | 11 | 11 | 7 | 29 |

**Table- 5: THE SPECTRUM OF EPIDIDYMO ORCHITIS & COMPLICATIONS**

| | Right | Left | Bilateral | Total |
|---|---|---|---|---|
| **Acute Epididymo orchitis** | 14 | 10 | 0 | 24 |
| **Chronic Epididymo orchitis** | 1 | 1 | 0 | 2 |
| **Funiculitis** | 5 | 1 | 0 | 6 |
| **Testicular abscess** | 1 | 2 | 0 | 3 |
| Total | 21 | 14 | 0 | 35 |

**Table- 6: SIDEDNESS OF INGUINOSCROTAL HERNIA**

| | Right | Left | Bilateral |
|---|---|---|---|
| **Inguinoscrotal hernia** | **10** | **5** | **2** |

**Table- 7: THE SPECTRUM OF VARICOCELE**

| | Grades of Varicocele | | |
|---|---|---|---|
| | **G1** | **G2** | **G3** |
| **Right** | 0 | 1 | 0 |
| **Left** | 1 | 0 | 9 |

**[G-Grade]**

**Table- 8: UNDESCENDED TESTIS LOCATION AND SIDEDNESS**

| | Right | Left | Bilateral | |
|---|---|---|---|---|
| **Inguinal canal** | 2 | 4 | 0 | 6 |
| **Abdominal** | 1 | 0 | 0 | 1 |
| | 3 | 4 | 0 | 7 |

**Table- 9: TORSION TESTIS SIDEDNESS**

| | Right | Left |
|---|---|---|
| **Torsion testis** | 2 | 4 |

**Table- 10: Ultrasonography and colour Doppler imaging appearance in epididymo orchitis.**

| Echopattern | Acute Epididymo orchitis | Chronic Epididymo orchitis |
|---|---|---|
| **Hypoechoic** | 19 | - |
| **Heterogenous** | 5 | 2 |
| **Testicular Calcification** | - | 1 |
| **Increased flow on Colour Doppler** | 24 | 1 |

**Table- 11 : Diagnostic validity of physical examination in Epididymo orchitis**

| | | Sonological diagnosis | | |
|---|---|---|---|---|
| | | **Positive** | **Negative** | |
| **Physical examination** | **Positive** | 26 | 11 | 37 |
| | **Negative** | 0 | 67 | 67 |
| | | 26 | 78 | 104 |

**Sensitivity = 100%**
**Specificity = 85.9%**
**Positive predictive value = 70.2%**
**Negative predictive value = 100%**

**Table- 12 : Diagnostic validity of physical examination in Varicocele**

| | | Sonological diagnosis | | |
|---|---|---|---|---|
| | | Positive | Negative | |
| Physical examination | Positive | 9 | 1 | 10 |
| | Negative | 1 | 93 | 94 |
| | | 10 | 94 | 104 |

**Sensitivity = 90%**
**Specificity = 98.9%**
**Positive predictive value = 90%**
**Negative predictive value = 98.9%**

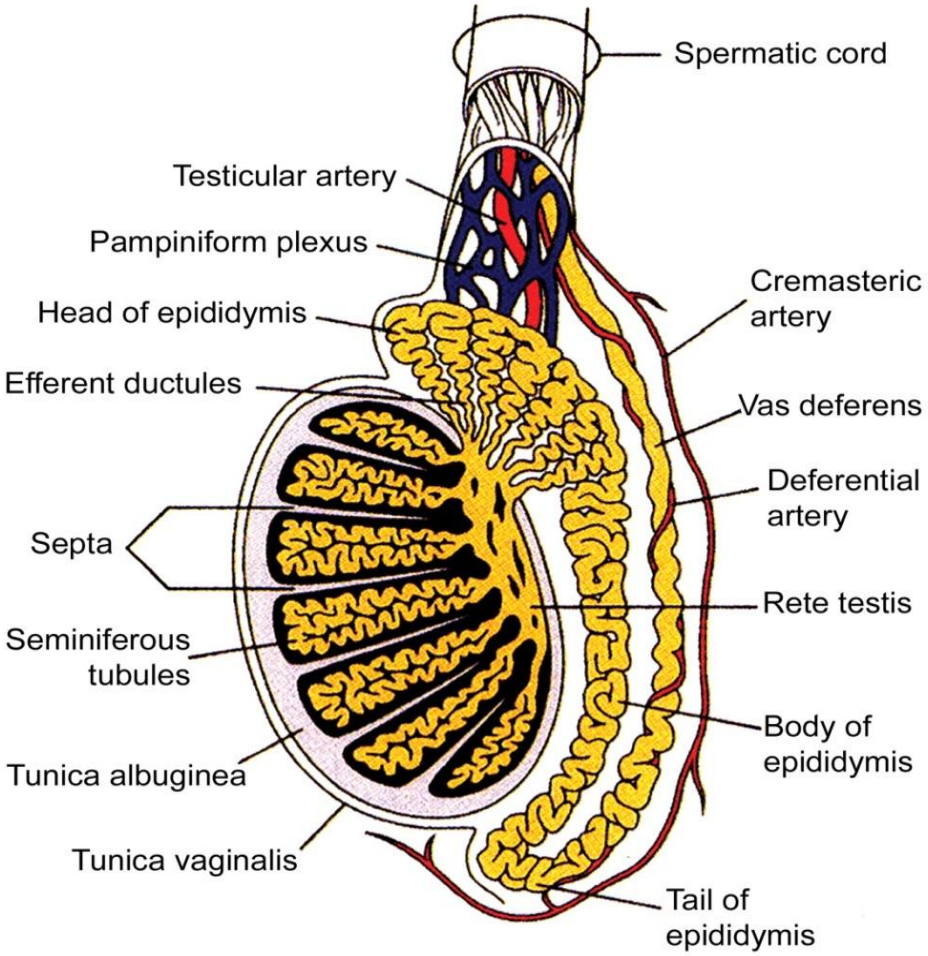


**Fig.1: Diagram of normal scrotal anatomy**

**Reference**: http://radiographics.rsna.org/content/27/2/357/F1.expansion.html

**APPENDIX OF TESTIS**

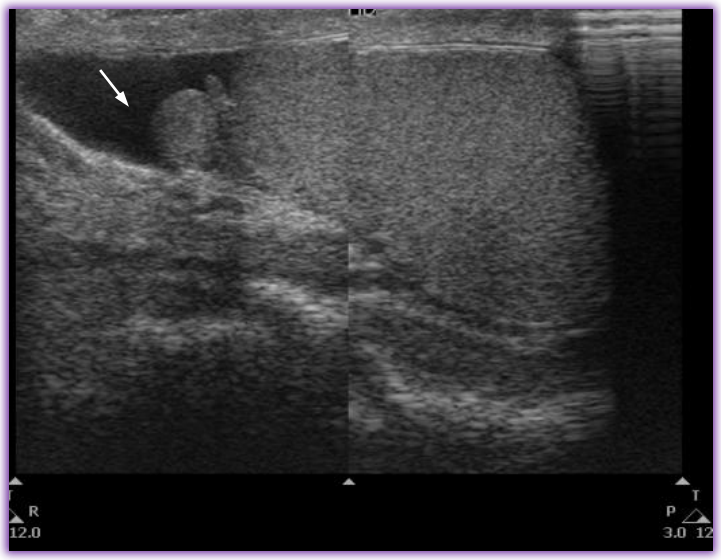

**Fig.2: Appendix of testis (Arrow) located at upper pole of testis.**

**HYDROCELE**

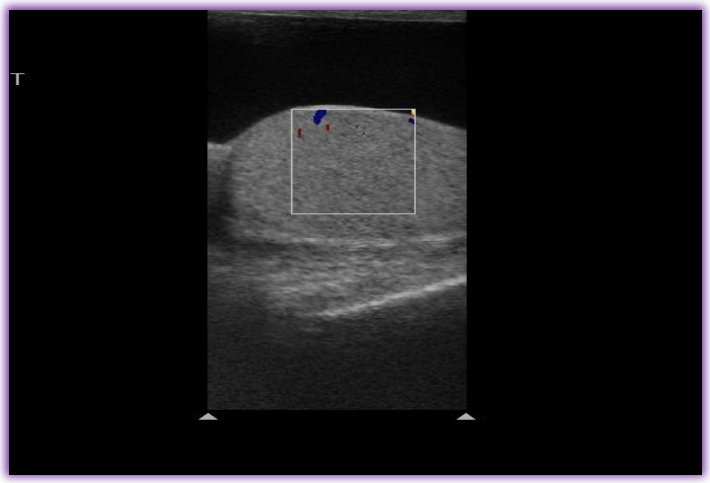


**Fig. 3: Longitudinal scan showing hydrocele (Case 94)**

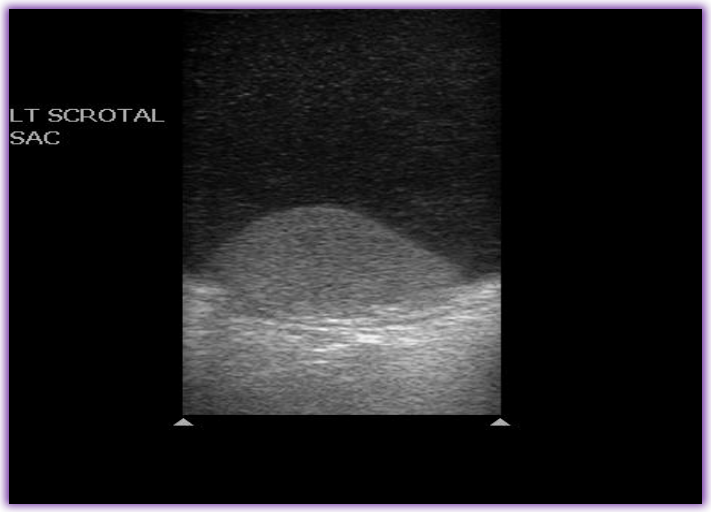


**Fig.4: Longitudinal scan showing hydrocele with internal echoes(Case 95)**

**EPIDIDYMITIS**

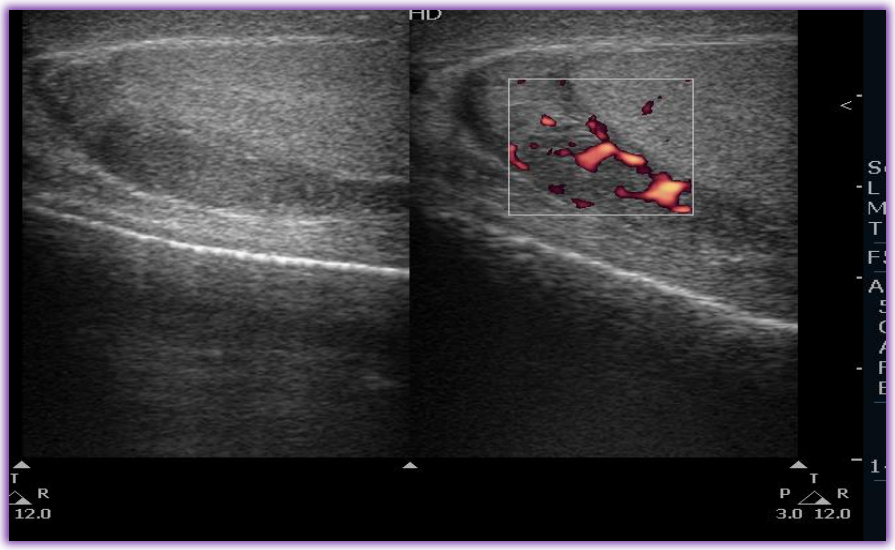

**Fig.5: Longitudinal scan showing hypoechoic epididymis with increased vascularity(Case 10)**

**ORCHITIS**

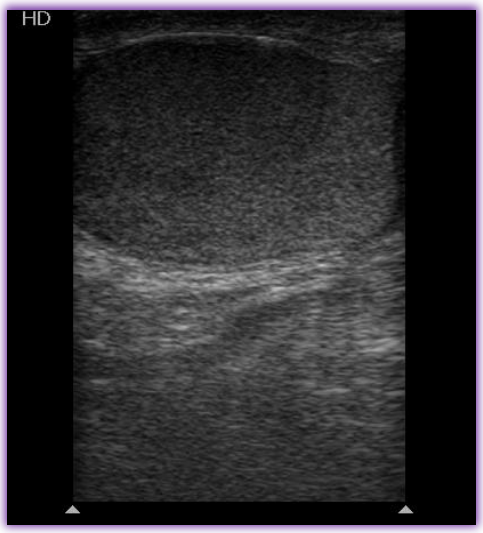

**Fig.6: Longitudinal scan showing hypoechogenicity of testis. (Case 33)**

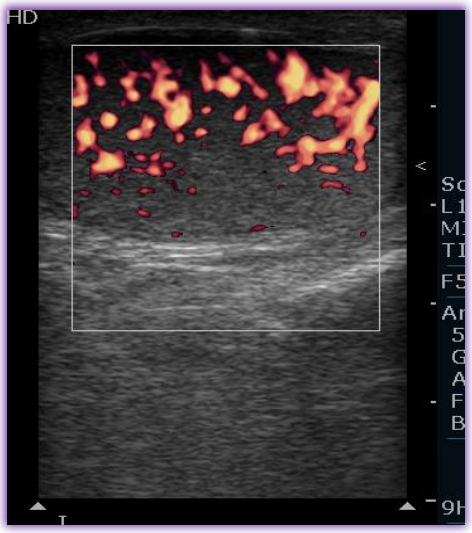

**Fig.7: Longitudinal scan of same case in Fig.6 showing increased vascularity in testis.**

**FUNICULITIS**

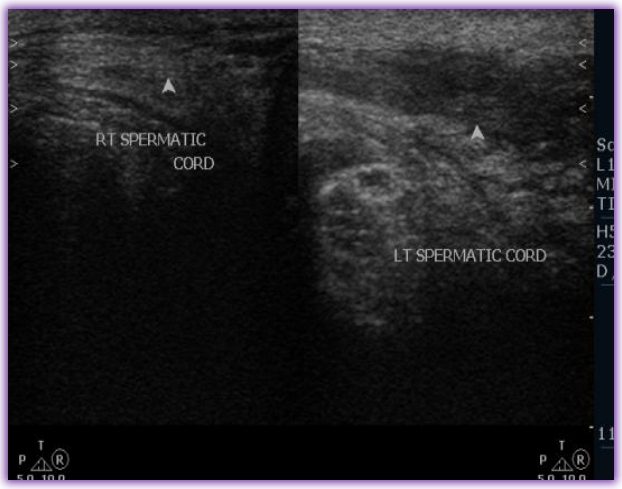


**Fig.8: Longitudinal scan showing thickening and hypoechogenicity of left spermatic cord compared to right.(Case 99)**

**TESTICULAR ABSCESS**

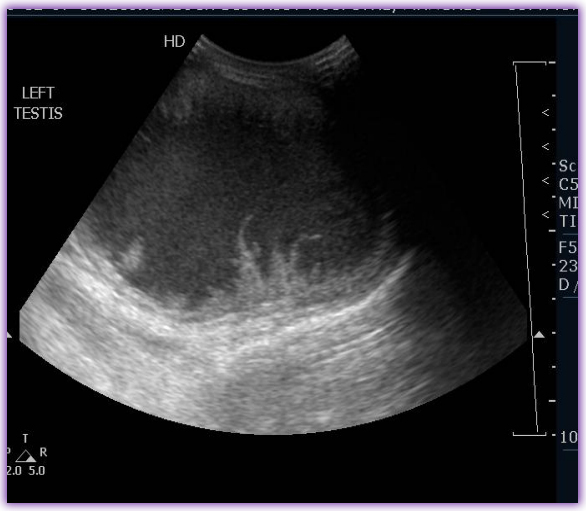


**Fig.9: Transverse scan of both testes showing abscess on left side (Case 45)**

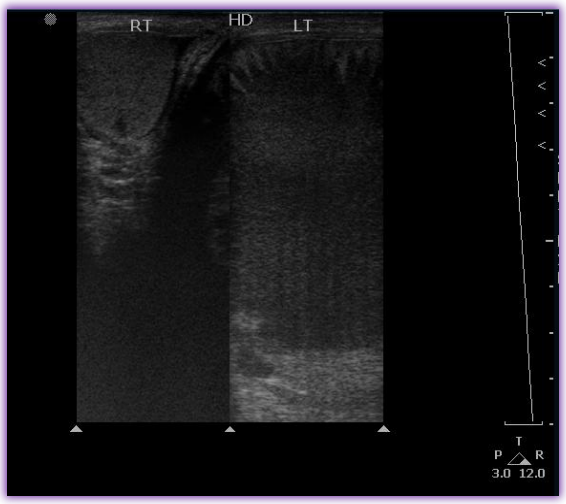


**Fig.10: Longitudinal scan from curvilinear transducer of same patient in Fig.9 showing abscess in left testis**

**SCROTAL WALL CELLULITIS**

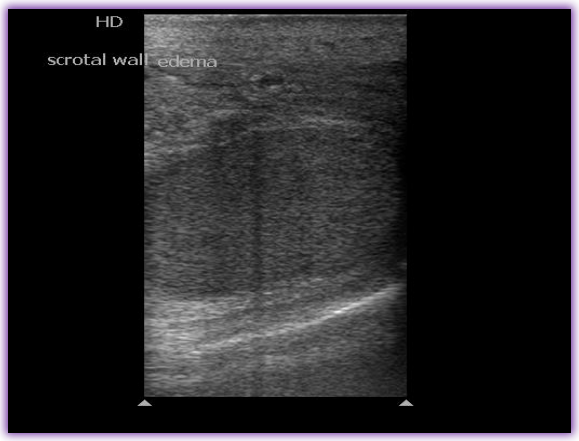


**Fig.11: Longitudinal scan in a patient showing scrotal wall edema(Case 87**

**TORSION TESTIS**

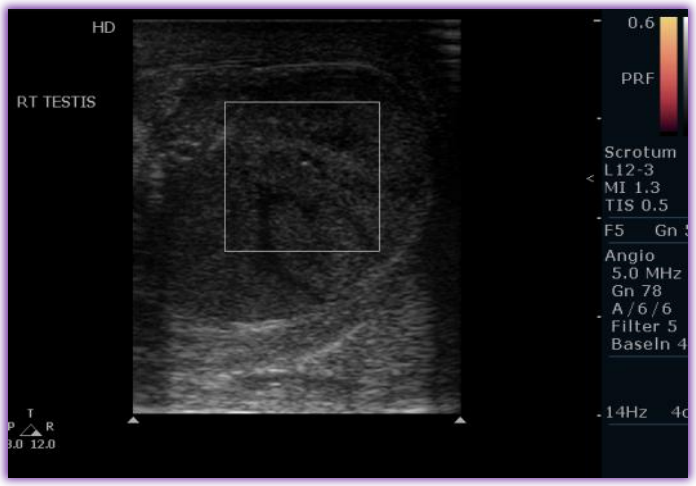


**Fig 12: Longitudinal scan with power Doppler showing hypoechogenicity and absence of flow in testis. (Case 21)**

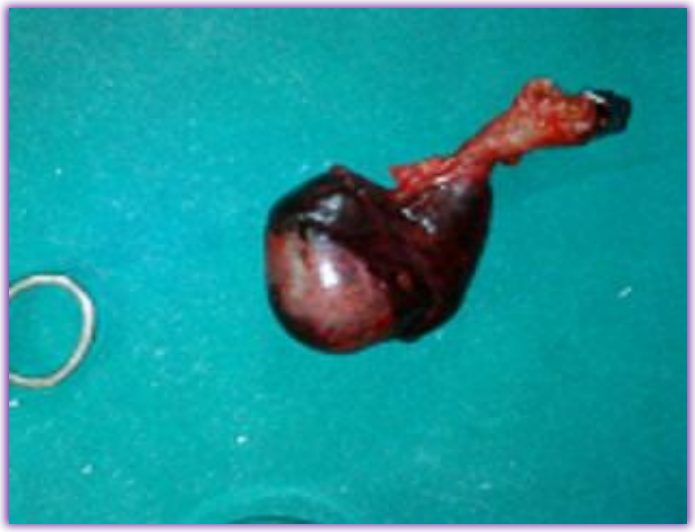

**Fig 13: Pathologic specimen after orchiectomy of same patient in Fig.12 showing discolouration.**

**UNDESENDED TESTIS**

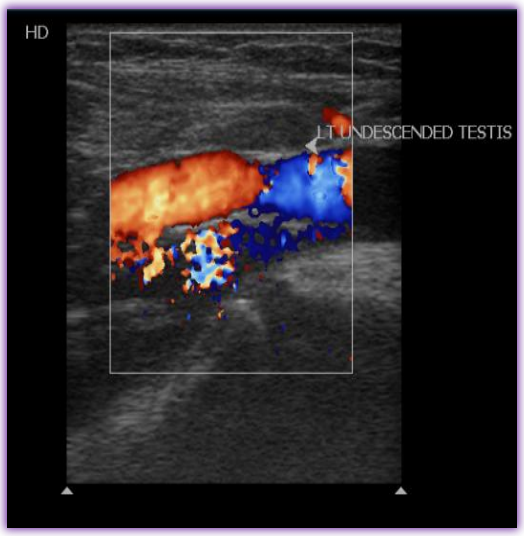


**Fig.14: Transverse scan showing left inguinal undescended small sized testis . (Case 2**

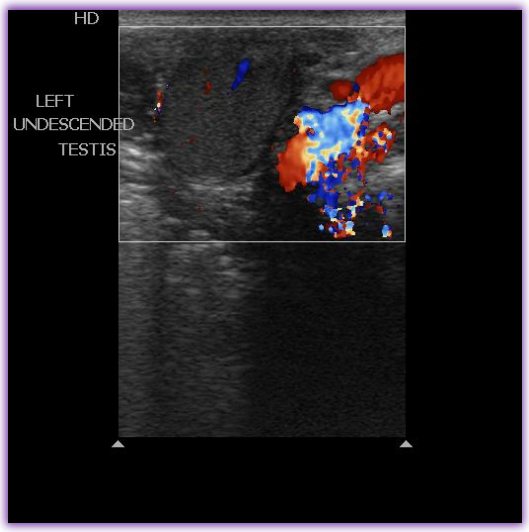


**Fig.15: Transverse scan showing left inguinal undescended testis in another case.(Case 89)**

**VARICOCELE**

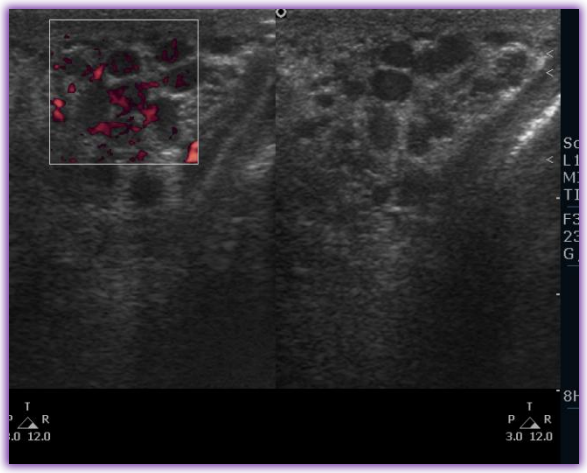

**Fig.16: Transverse scan and power Doppler showing dilated pampiniform plexus of veins. (Case 44)**

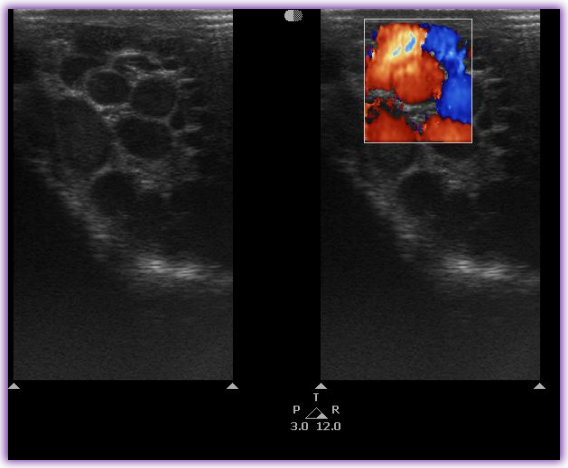

**Fig.17: Transverse scan and colour Doppler in another case showing dilated pampiniform plexus of veins. (Case 29)**

**TESTICULAR MICROLITHIASIS**

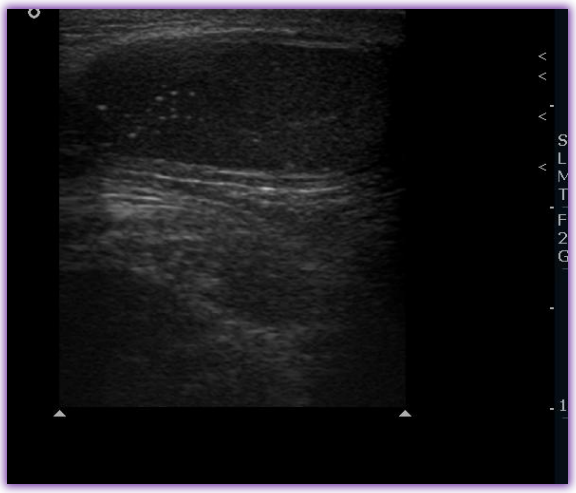

**Fig 18: Longitudinal scan showing multiple small hyperechoic foci in testis. (Case 4)**

**SCROTAL FILARIASIS**

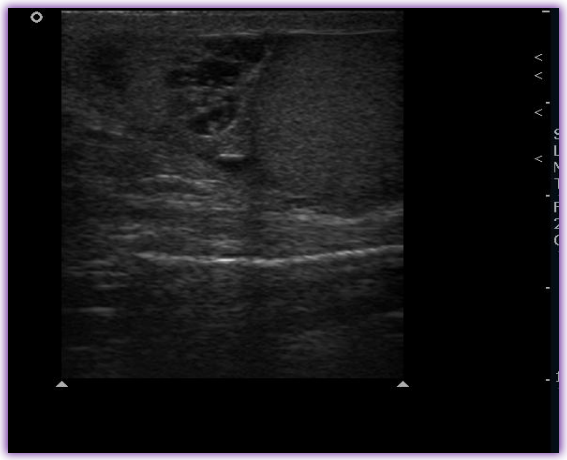

**Fig.19: Longitudinal scan showing dilated lymphatic spaces with echogenic foci.(Case 19)**

**DISCUSSION**

## SUMMARY

Ultrasonography with colour Doppler has been performed in 104 cases presenting with various scrotal conditions. The range of pathologies diagnosed by this modality is described and diagnostic accuracy has been evaluated. Clinical application and usefulness of the diagnostic method is discussed.

In our study, larger number of patients were in age group of 21 to 40 years and scrotal pain with swelling was commonest presenting complaint. It is observed that hydrocele was the commonest diagnosis and inflammatory diseases with various complications formed single largest pathological group.

In present study, ultrasonography is found sensitive in diagnosis of epididymo orchitis, inguinoscrotal hernia, testicular microlithiasis and testicular neoplasms. Ultrasonography also helped in differentiating intra and extratesticular swellings, solid from cystic swelling and in diagnosing coexisting pathologies in cases with hydrocele. Use of colour Doppler flow imaging is found sensitive for diagnosis of testicular ischemia, varicoceles and strangulated hernia.

## CONCLUSION

In present study about 104 cases were studied with ultrasonography and Colour Doppler flow imaging,

- Commonest clinical presentation was scrotal swelling with pain.
- Largest number of patients belongs to the age group of 21 to 40 years, which constituted 50.9 % of all cases.
- Hydrocele was the most common diagnosis followed by epididymo orchitis.
- Inflammatory diseases with various complications constituted largest single pathological group.
- The colour Doppler sonography accurately differentiated between testicular ischemia and torsion from acute inflammatory diseases in acute painful scrotal conditions.
- Colour Doppler is sensitive in detection of varicoceles in comparison with physical examination.
- Ultrasonography is sensitive in diagnosis of testicular microlithiasis which cannot be diagnosed clinically and require followup scans owing to high incidence of occurence of malignancy in such cases.
- Ultrasonography can differentiate testicular from extra testicular swellings and solid from cystic scrotal masses and sensitive in diagnosis of neoplastic scrotal swellings.
- Ultrasonography with colour Doppler is sensitive in diagnosis of inguinoscrotal hernia and in detection of strangulated hernia.

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