"ROLE OF ULTRASOUND WITH COLOR DOPPLER IN DIAGNOSTIC EVALUATION OF ACUTE SCROTUM"

By

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In partial fulfillment of the requirements for the degree of

DOCTOR OF MEDICINE

In

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Under the guidance of

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Place: Vijayapur. ***Dr. Avinash kumar***

ABSTRACT

Background & Objectives:

Acute scrotum has different causes & etiological factors. Although some causative factors like epididymo-orchitis can be treated with medical management, but some conditions like torsion, incarcerated hernia & fournier's gangrene require immediate surgical intervention to treat the patient. Ultrasound with color Doppler is a significant tool to rule out these etiologies for acute scrotum & it helps to take a proper decision for the benefit of patient.

This modality is cheap, easily available and does not cause exposure of radiation to gonads. So it can be utilized for the diagnosis in such cases. This study was done to find out the diagnostic capability of ultrasound and color Doppler in acute scrotum cases.

Methods:

Patients of acute scrotal pain who came to Shri B. M. Patil medical college, Hospital and Research centre, Vijaypur, Karnataka and referred to Department of Radiology for sonographic evaluation were taken for study. It was conducted from November 2015 to April 2017. Patient was examined in supine position. A rolled sheet was placed between legs for scrotal support. A high-frequency probe was used for scanning in transverse and sagittal planes. Lower frequency transducer was used in cases of enlarged scrotal sac. Echotexture & vascularity of both the testis & epididymis were evaluated. Siemens Acuson X700 and Philips HD11-XE.

Results:

In our study of 50 patients presenting with acute scrotum, 5 cases were of torsion. Epididymo-orchitis was diagnosed in 36 cases. Incarcerated hernia was present in 2 cases & 7 cases were of varicocele. To confirm the diagnosis, follow up of surgical or medical management was taken. One case of epididymo-orchitis was misdiagnosed which further proved to be varicocele. Rest cases were correct in the diagnosis.

Interpretation & Conclusion: In our study, whirlpool sign with absence of vascularity in distal spermatic cord and testis was the key finding for torsion cases. Increased vascularity in epididymis & testis were the indicative parameters for epididymo-orchitis. For incarcerated hernia, the diagnostic point was akinetic bowel loop in the inguino-scrotal region with absent or minimal vascularity of that bowel loop. For varicocele, dilated venous channels with reflux on valsalva maneuver was considered.

Ultrasound with color Doppler is an excellent modality for diagnosis of acute scrotum.

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INTRODUCTION

The clinical features of acute scrotum are usually pain or scrotal swelling or both occurring simultaneously. In maximum cases, conservative or non-surgical approach can be followed but if there is spermatic cord torsion, immediate surgical intervention has to be done so that testis can be preserved. So, here ultrasound with color Doppler provides an important modality option to differentiate between these causes & help in proper management.[1]

The frequent etiological factors for causing pain in scrotum are epididymo-orchitis and spermatic cord torsion. It is very difficult to differentiate these conditions solely based on physical examination or laboratory tests and results may not be accurate in 50% of patients.[2]

The term of testicular torsion actually represents the spermatic cord twisting & also the contents within it are affected. Torsion is an emergency condition in the surgery department. The incidence of testicular torsion is 3.8 per 100,000 males per year in a patient age group of less than 18 years.[3]

If surgery of torsion case is done within six hours, the chances of preserving the testis are approximately 80 to 100 percent. If the operative intervention takes longer duration of about six to twelve hours, there are approximately seventy percent chances for testicular preservation.

If more than twelve hours are taken for surgical procedure, only twenty percent chance is there for testicular preservation.[4]

Henceforth, it is important and urgent to differentiate between torsion and infective pathologies like epididymo-orchitis to decide further course of action as surgical exploration is required for torsion cases for salvage of testis while epididymo-orchitis can be conservatively managed.

Other modalities for evaluation of acute scrotum have limitations like MRI is expensive, not easily available and less tolerable to irritable patient due to longer duration of examination and CT scan causes radiation to gonads. However sonography is cost effective & widely available. There is no radiation exposure and the process is relatively of shorter duration. Scrotum is superficial structure so it can be easily examined by high resolution sonography. Utilization of gray scale sonography with color Doppler provides relevant and required anatomical details along with vascularity, thereby providing the diagnosis.

OBJECTIVES

1) To study cases of acute scrotum with ultrasound & note the diagnostic appearances of various diseases.
2) To study cases of acute scrotum with color Doppler & note the diagnostic appearances of various diseases.
3) To correlate sonographic findings with clinical follow up & post operative diagnosis.
4) To find out limitations of sonography and color Doppler for acute scrotum evaluation.

METHODODLOGY

1. Study design: Type of cross sectional study**.**

2. Source of data: Patients with complaint of acute scrotal pain coming to Shri B. M. Patil medical college, Hospital and Research centre, Vijaypur, Karnataka and referred to Department of Radiology for ultrasound evaluation.

3. Institution / department: Radiology department of Shri B.M. Patil medical college, hospital and research centre, Vijaypur, Karnataka.

4. Duration of study: November 2015 to April 2017.

5. Method of data collection:

First relevant history was taken from the patient with reference to complaint of type and onset of scrotal pain, swelling in scrotal region, any previous history of similar complaint and any other history of medical or operative significance.

Then for ultrasound examination, patient was asked to lie down in supine position. After that a rolled sheet was placed between legs to provide scrotal support. Then displacement of penis was done superiorly or supero-laterally. A high-frequency probe (frequency ranging from 7.5–15 MHz) was utilized for scanning in transverse as well as sagittal planes. Lower frequency transducer (3-5 MHz) was used in cases of significantly enlarged scrotal sac. Both testes were examined along with their size measurements. Echotexture and vascularity of both testis & epididymis were noted.

Imaging was done on long and short axes. Color Doppler imaging was used to identify vascularity in the scrotal contents.[5]

The machines used in the study were Siemens Acuson X700 and Philips HD11-XE.

6. Sample size

Based on the incidence of patients for epididymo-orchitis (0.69%).[6]

At 99% confidence level and 3% allowable error the sample size = 50

$$n = \frac{z\sim^2 p(1-p)}{L^2}$$

Here, Z_{α} = Z represents value for α at confidence level of 99 %

P = proportion of incidence

L = allowable error of 3 %

7. Statistical analysis: Data was analyzed using diagram, mean ± SD, proportions.

INCLUSION CRITERIA: Patients with complaint of acute scrotal pain.

EXCLUSION CRITERIA: Patients with trauma to scrotum.

REVIEW OF LITERATURE

Ultrasound technology

Sonography or the ultrasound terms are usually interchangeably used in medical field. However actual meaning of the word is derived from two components namely ultra, referring to high or excessive and the sound referring to the sound waves. Henceforth the term ultrasound refers to the excessive or significantly higher amount of sound waves. Normal human ear can utilize the sound waves of frequency up to 20 kilohertz or 20,000 hertz. [7]

High range of ultrasonic waves of frequency ranging from 3 megahertz to 10 megahertz is utilized for sonography in medical field.

Basic principle:

Ultrasound waves are generated by piezoelectric effect in which electric field is applied to a crystal. Due to this electrical field, internal structure of the crystal is affected & vibrations are produced. These vibrations are the form of mechanical energy & are responsible for production of high frequency ultrasonic waves.

These waves are transmitted by the transducer towards the area of interest. Human tissue is not uniform in nature, so these ultrasonic waves are reflected back in a different fashion due to different acoustic impedance. Resistance in the sound wave movement is referred as Acoustic impedance. Internal structure or density of objects is responsible for acoustic impedance & hence for passage of sound waves. In High density material, there is more reflection of sound waves.[8]

These reflected waves are picked up by transducer. The difference in the intensity among them after the reflection is responsible for image production. Predominantly, B mode of ultrasound is used for diagnostic purposes. In this B mode, white & black images are produced in a 2D format.[9]

Few important parameters should be taken into consideration. If higher frequency waves are utilized they imply few things. First, the resolution will be better & clear depiction of region of interest is present. Secondly, energy of waves is directly proportional to the frequency, so we will be applying more amount of energy to the region of interest, therefore, more amount of heating effects are present. Thirdly, on increasing the frequency of ultrasound waves, wavelength is decreased as they are inversely related. So waves cannot penetrate in the region of interest in deep structures.

Hence optimal setting of the frequency of sound waves is required for achieving results. This is especially relevant in cases of scrotum examination. Scrotum is the structure which is present superficially. There is no need to go for low frequency high wavelength waves which are required for deeper structures but they compromise on resolution. High frequency ultrasonic waves which provide good resolution can be utilized for scrotal examination.

Historical aspect of ultrasonography[10,11,12]

In earliest of available documents, in 1794, Lazzaro Spallanzani, physiologist was the person who proposed mechanism of spatial orientation & also that the bats navigate through the echolocation mechanism.

Jean D.Colladon, a physicist in 1826, took utilization of a church bell which was placed under water for the sound speed calculation. He proved that sound waves travel faster in the water as compared to that of air.

Galton developed a system so as to create sound waves which were having frequency of 40000 Hertz in1880. J. P. Curie found that mechanical vibrations in the quartz crystal produces electricity. He called this piezoelectric effect.

Richardson utilized propagation of ultrasound waves in the water for identification of objects present under water and developed echolocator for the same. It was done in 1912.

Sokolov suggested sound wave transmission theory in 1929 & later on ultrasound waves were utilized in the identification of metal construction work defect.

During 1930s, initially ultrasound waves were utilized for therapeutic effects instead of diagnostic uses. Significant amount of heat energy was produced by these ultrasonic waves which lead to destruction of tissues. Such destructive capability of these ultrasound waves was utilized by William fry and Russell Meyers in Parkinsonism disease by destroying basal ganglia components.

In1953, rheumatic arthritis was also attempted to be treated by utilization of sonic waves by Jerome Gersten. Similar attempts were there for the meniere's disease.

In 1937, cerebral chambers visualization & detection by using ultrasound waves was attempted by Dussig brothers but they could not succeed as ultrasound waves could not cross the bony structures. Pulse ultrasound waves were utilized by Ludwig and Stuthers so as to identify gall bladder stones.

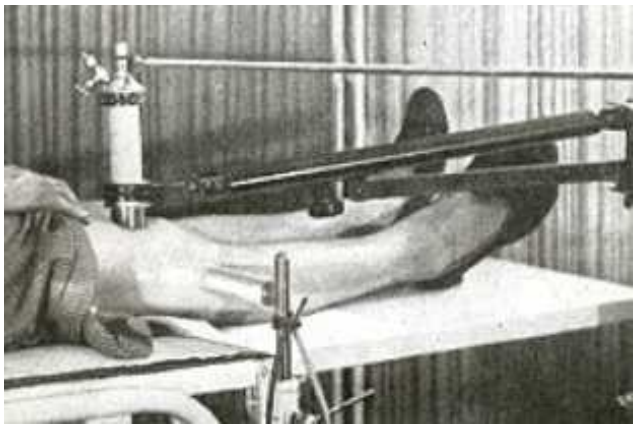


Figure no. 1[13]

Use of ultrasound waves in arthritis treatment

Figure no. 2 [13]

Ultrasound waves generator utilized for therapeutic effects

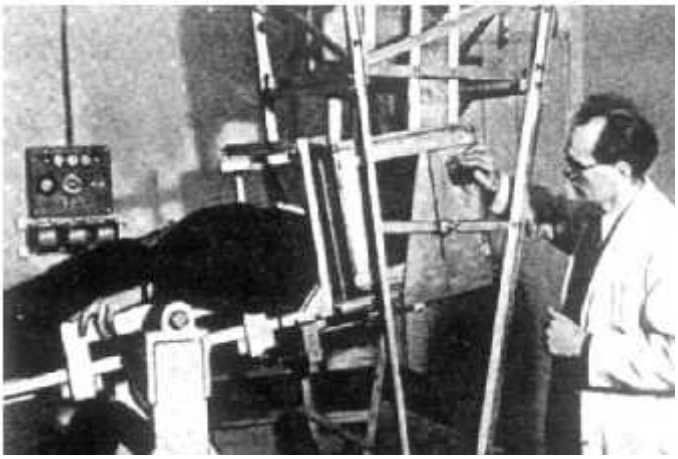


Figure no. 3[13]

Apparatus of Carl dussik (1946)

Figure no. 4[13]

Ultrasound scanner by Ian Donald & Brown

Ian Donald brought the ultrasound for the consideration of diagnostic medicine. He utilized the one-dimensional A mode also called as amplitude mode for measurement of head of fetus in 1956. He measured parietal diameter.

In 1958, a female genital tumor was imaged by using ultrasound by Donald & Brown. A two-dimensional compound scanner was developed by Brown in which tissue density could be identified. This was considered as remarkable breakthrough in the history of ultrasound.

In 1963, the use of ultrasound devices started commercially in the medical field. Here Brightness mode also known B mode devices were made in which two-dimensional image could be seen.

Doppler development [14,15,16]

In 1959, an instrument was developed which had the capability of quantifying the blood flow velocity in a vessel by using the technique of measuring the time passed between 2 electrical pulses. This was called multichannel transit-time flowmeter. It was developed by Franklin, Ellis and Donald Baker. In 1965, the Doptone was rolled out by Smith Kline instruments which could detect fetal pulsations based on the spectral work by Baker.There was technology transfer between Donald baker & Advanced Technology Laboratories Company. They rolled out Mark I scanner in 1975 & then in 1978 the Mark Vduplex scanner came into the market.

Testicular ultrasound & Doppler started predominantly in 1970s. In 1975, Ian thompson described absence of blood flow in testis by utilizing the Doppler ultrasonic flowmeter. He described such absent flow in 7 cases which was confirmed on surgery for torsion.[17]

In 1978, W F Sample conducted a study of scrotum examination by ultrasound in 110 patients. It was concluded that origin of the disease could be determined in 80% cases. If the sonogram was negative for pathology, it was considered a highly reliable sign.[18]

In 1980, according to Philips et al, reduced echogenicity was a feature of torsion. Arger et al, in 1981, opined that the patients of testicular torsion and of inflammatory pathologies could not be differentiated. However in 1985 Chin & Miller considered hyperechoic testis as sign for testicular torsion. So, authors were having different opinion about echotexture of testis for torsion cases. Later by mid 1990s color Doppler was considered effective to rule out the torsion & other inflammatory pathologies.[19]

ANATOMY

The shape of scrotum is saccular. It consists of two compartments. Median raphe separates these two compartments.

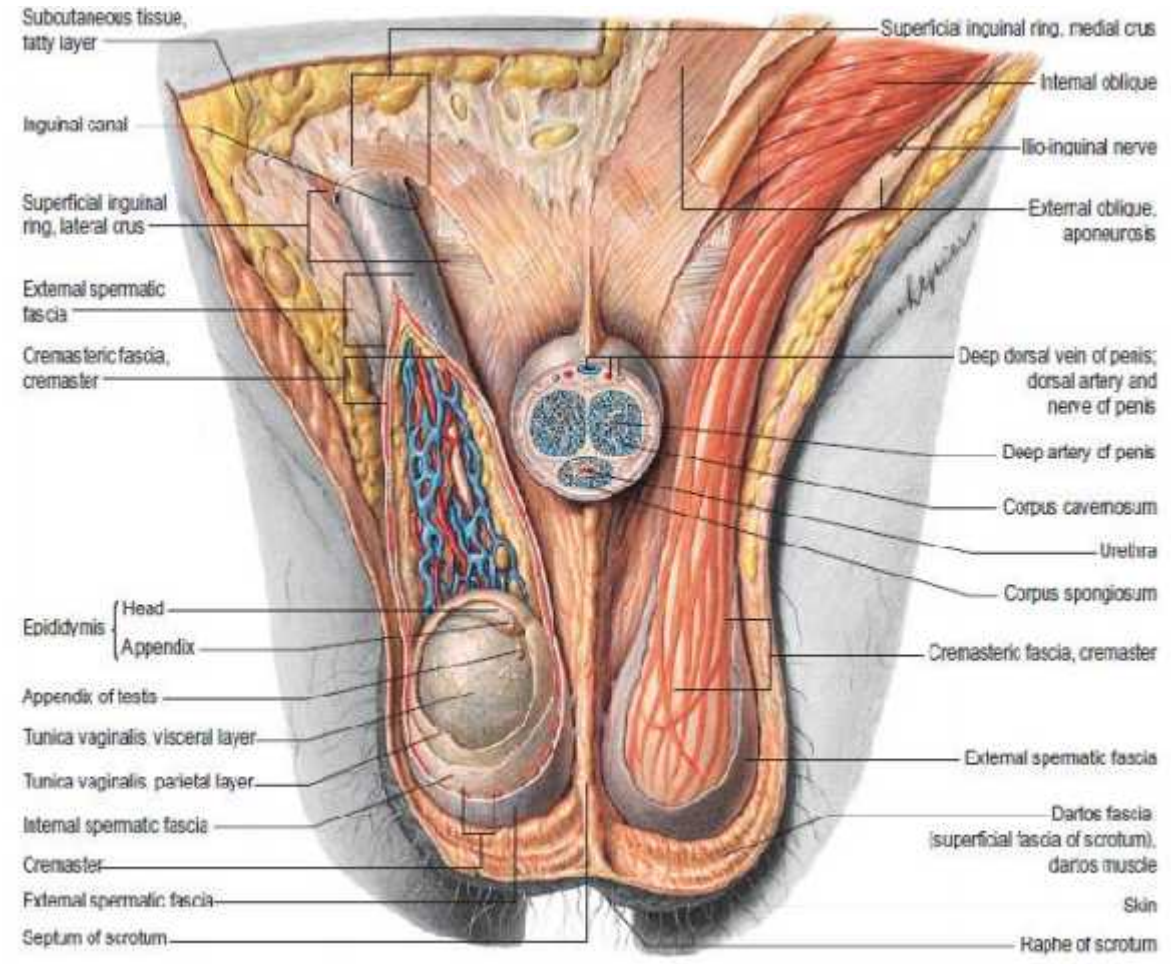


Figure no. 5 showing Scrotal anatomy [20]

Testis

The testis is covered by tunica albuginea which is a thick capsule.

There are 2 layers of tunica albuginea.

1. Visceral layer: It is the layer which forms a covering over whole of testis except the posterior part.
2. Parietal layer: It is situated along the wall of scrotum.

Testis is covered by tunica albuginea, but it is not seen in the sonography in normal case. If fluid is present surrounding the testis, then it can be seen. The tunica albuginea further goes to mediastinum, thereby dividing it into lobules which may be in hundreds of numbers.

There are seminiferous tubules in every lobule which further proceed to mediastinum testis & form the rete testis. Further ahead these tubules drain into efferent ductules from where the sperms are transported to ductus epididymis. Ductus deferens is its continuation but present outside epididymis. The echogenicity of testis is usually homogenous.[21]

The normal size of adult testis is approximately three cm in antero-posterior diameter. Its width ranges from two to four cm while length varies from three to five cm. The shape of testis is oval. The weight varies from 12.5 to 19 grams for testis. [22,23]

Echogenicity in the age group below puberty is that of low to average. In age group of puberty & after puberty, there is homogenous echotexture which actually indicates germ cell development & maturation.[24]

Band like structure which is significantly echogenic & is variable in size, actually represents mediastinum testis. It usually runs in supero-inferior direction.[21]

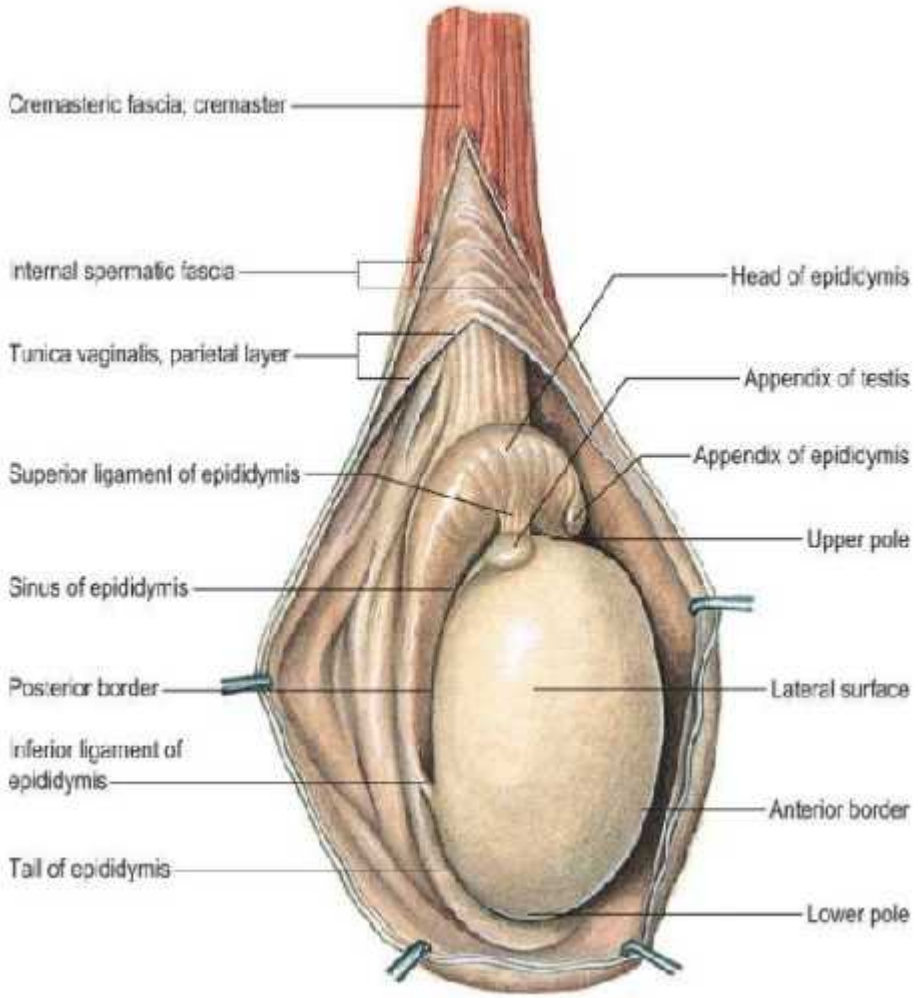


Figure no. 6 Showing scrotal anatomy[20]

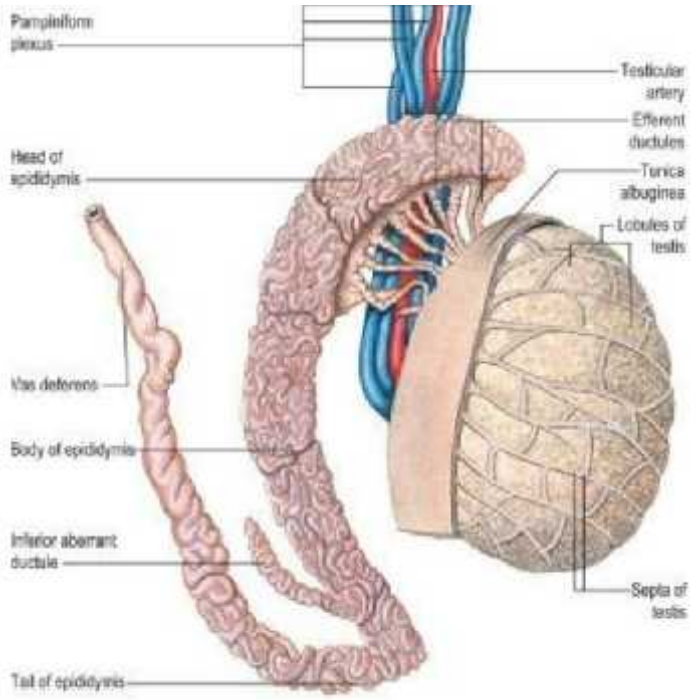


Figure no. 7 Showing epididymis and testis anatomy [20]

Epididymis

Location of epididymis is posterior & lateral to testis. The size of epididymis varies from six to seven cm.The appearance of epididymis on ultrasound is isoechoic to hyperchoic as compared to the adjacent testis. Coarse echogenicity of epididymis can be noted as well. The components of epididymis are head, the body & the tail parts. The biggest part is epididymal head. The head of epididymis is also known as globus major. It is a pyramid shaped structure & it is present supero-laterally to the testicular upper pole. The size of globus major ranges from five to twelve mm. Body & tail part of epididymis are relatively smaller in size & their location is variable as well.[25,26]

Arterial supply

Deferential artery, cremasteric and testicular arteries provide the blood supply to testis.

There is one testicular artery on each side. Testis is primarily supplied by these testicular arteries. From the abdominal aorta, they are originated. They originate distal to renal arteries. After that they move to inguinal canal along with the spermatic cord to reach postero-superior part. After reaching to testis, these are divided into many branches. These penetrate through tunica albuginea and & then they form tunica vasculosa which is a layer of vessels. After that, there are centripetal branches which originate from capsular arteries and supply mediastinum. At the mediastinum, they divide so as to form recurrent rami which provide blood supply from mediastinum towards the testis.[27]

Next is the deferential artery which originates from superior vesicle artery. Another artery is the cremasteric artery which arises from inferior epigastric artery. Both of these supply the vas deferens & the epididymis. Also. the peritesticular tissue is supplied by these two arteries. [28]

Venous drainage & lymphatics

There is formation of pampiniform plexus around upper half of the epididymis which further forms the testicular vein. After that the blood is drained from left testicular vein into left renal vein while the blood is drained from right testicular vein into inferior vena cava.[29]

Lymphatic vessels follow the arteries. Lymphatic fluid is drained into lumbar lymph nodes. Cremaster muscle & skin of the scrotal region is supplied by genitofemoral nerve's genital branch which arise from celiac plexus.

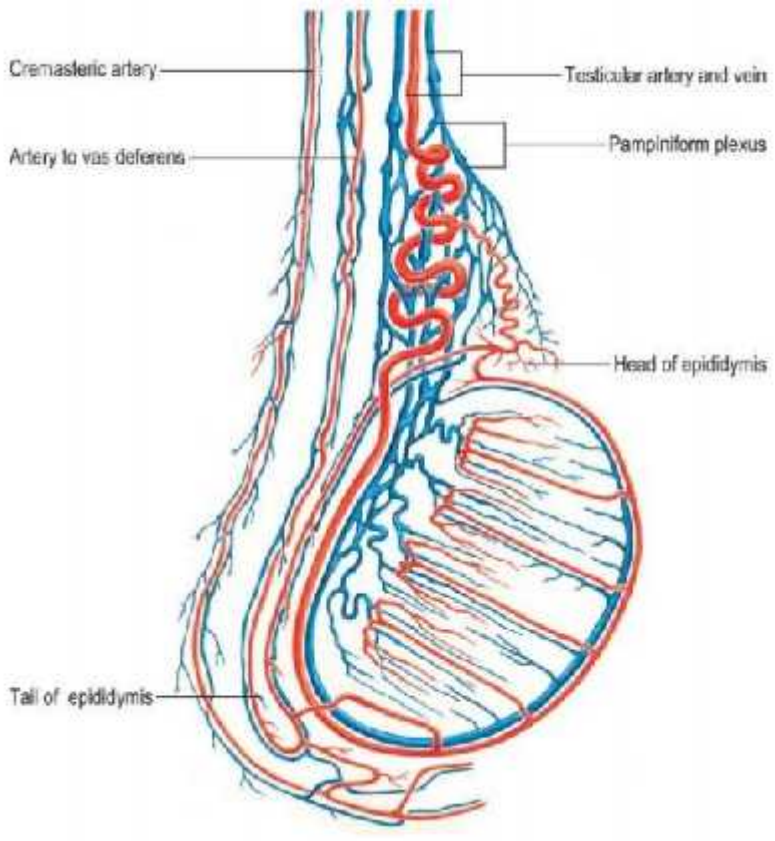


Figure no. 8 showing arterial supply & venous drainage to testis [20]

Testicular Appendages [30,31,32]

These are basically remnants of embryonic ducts.

1. Appendix testis
2. Appendix epididymis
3. Vas aberrans
4. Paradidymis

Out of these, appendix testis and appendix epididymis can be seen in ultrasound.

Appendix testis is mullerian duct remnant. It is composed of fibrous tissue & the blood vessels enclosed in the columnar epithelium. It is present in groove like area between testis & epididymis and also there is an attachment to testicular upper pole. Appendix epididymis is also attached to the epididymal head.

Spermatic cord starts at deep inguinal ring after that it traverses into scrotum. It is composed of cremasteric, deferential & testicular arteries, genital femoral nerve, pampiniform plexuses, lymphatic vessel and vas deferens.

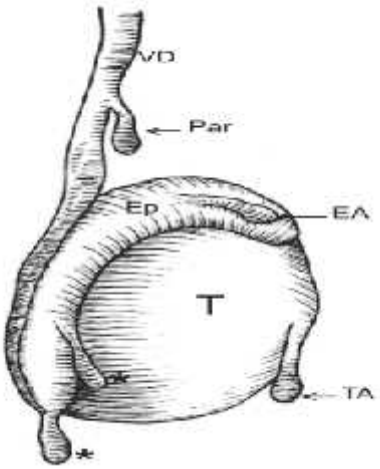


Figure no. 9 showing testicular appendages. [31]

Embryology [33,34,35]

Embryo at the time of development is bisexual at first. After that, the migration & movement of germ cells occur to retroperitoneum & hindgut. Here they are condensed in urogenital ridge so as to form ovary or the testis. For the formation of testis, Y-chromosome is required. Y-chromosome has a sex-determining region or SRY. It causes the encoding for DNA-binding protein required for differentiation of testis. In 7^{th} week, seminiferous tubules are developed with sertoli cells and surrounding germ cells. From interstitial mesenchyme, the Leydig cells differentiation occurs. The elements of female duct are repressed by mullerian inhibiting substance (MIS) which is produced by Sertoli cells.

After that, testosterone is produced by leydig cells in the tenth week. This testosterone is required for the development of seminal vesicles, vas deferens and the epididymis from the wolffian ducts. During 10 o 15 weeks, the enzyme 5-alpha reductase is required for conversion of testosterone into dihydrotestosterone so as to form & differentiate phallus and the scrotum. First the sexual differentiation of the testis occurs & after that descent of testis takes place.The testis reaches to inguinal region by fifteenth week & by 28th week it passes by inguinal ring. By 35–40 weeks it normally reaches to scrotum.

In the 5^{th} week, there is development of gubernaculum. It guides the movement of testis down into the scrotum. There is attachment of gubernaculum to inguinal abdominal wall, cauda epididymis, wolffian duct & to the gonad. Swelling of gubernaculums causes

testicular movement & migration into peritoneal outpoching which is called as processus vaginalis. The processus vaginalis forms a covering around epididymis & the testis with exemption of attachment posteriorly where epididymis is connected to scrotal wall. Through the spermatic cord, the testis is attached or suspended lower down. Spermatic cord contains spermatic artery & vein, thereby responsible for nutrition of testis apart from attachment.

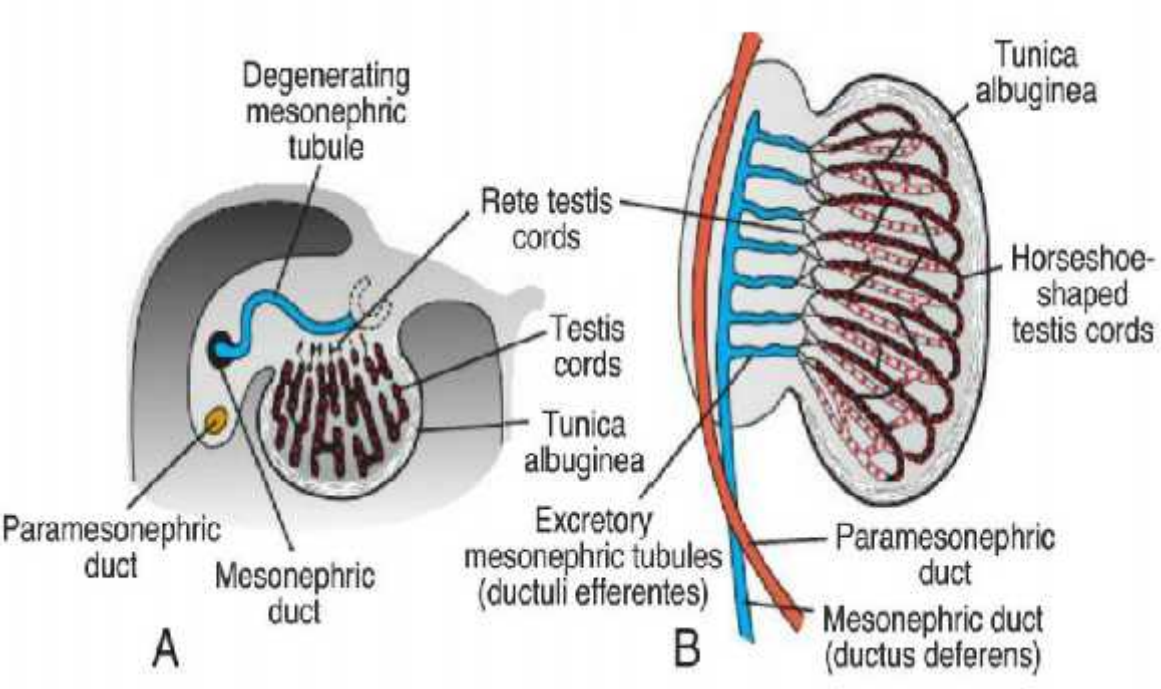


Figure no. 10 A. Formation of testis at 8th week B. Testis at 4th month [35]

Diseases

Testicular torsion or spermatic cord torsion

Introduction

In 1840, Delasiauve provided the term Testicular torsion in a case of undescended testis.In a normal descended testis, the first case of testicular torsion was mentioned by Langton in 1881. Scudder noticed 32 torsion cases of torsion mentioned in the literature by 1901.But still, it was considered rare by that time. Later, 9 cases were reported by Wheeler and Clark in 1952. Also, 20 cases of torsion were reported by Deming and Clarke.[36]

Torsion was more frequentluy recognized in 1970's with over one thousand cases.[37] Testicular torsion was defined as rotation of testis in longitudinal axis of the spermatic cord by M. Micallef et al. It is considered as surgical emergency.[38]

Incidence: In males less than 25 yrs of age, the occurrence is about 1 in 4000. In other words, 1 out of 160 males face this problem. [39] In 2010, Korkes et al. described the incidence of torsion as 1.4 out of 100 000 men.[40]

Surgical management & salvaging of testis

Lewis et al. found out that no exact time duration for operative management could be fixed, but preservation of testis reduces significantly if duration of insult is more than that of six hours. [41]

Ringdahl and Teague concluded preservation rate of affected testis are ninety %, fifty % and less than that of ten %, if the detorsion is done within respective six, twelve & twenty four hours after starting of symptoms. Henceforth, early identification of torsion is important to preserve the testis.[42]

Types of torsion

1. Extravaginal torsion : In this type of torsion, there is twisting of entire spermatic cord.

2. Intravaginal torsion : In this type of torsion, there is twisting of spermatic cord but within tunica vaginalis.

Intravaginal torsion is considered to be common in prepubertal & pubertal age group. Extravaginal torsion is considered common for neonatal age group. [37]

Also similarly, Pillai and Besner concluded that extravaginal testicular torsion typically occurs in neonate age group & it is relatively less common, approximately 10% of total cases of torsion. Further it was elaborated that there is rotation of both epididymis & testis testis along with the tunica vaginalis. Therefore there is twisting of spermatic cord above the level of tunica vaginalis. [43]

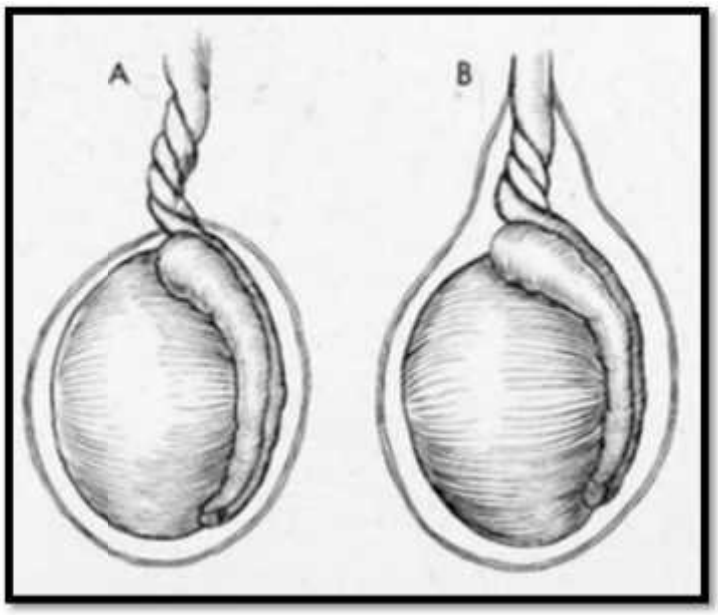


Figure no.11

A: Extravaginal torsion B:Intravaginal torsion [44]

Bell-clapper deformity

It was described by Muschat. Here the testis & the epididymis are totally covered by tunica vaginalis and there is no posterior attachment. Also, high investment of the tunica vaginalis is present in spermatic cord. This type of unique anatomy permits the testicular rotation intravaginally in a freehand manner. Due to this, often testis is present in horizontal position instead of vertical inside the scrotal sac.[45]

Hayn et al. concluded in a study of forty seven patients who underwent surgical management for torsion, that "bell-clapper'' anatomical deformity was significantly associated with torsion.[46]

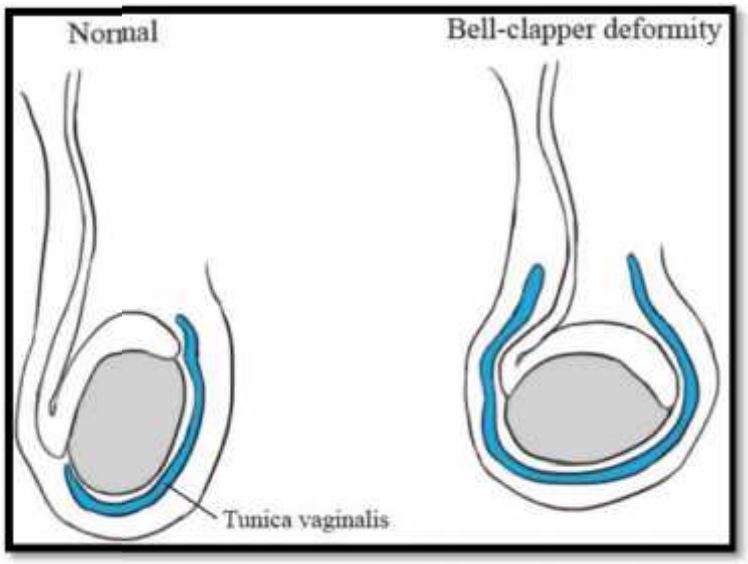


Figure no. 12 [47]
On the left: Normal tunica vaginalis
On the right: Bell clapper deformity: spermatic cord, testis and epididymis covered by tunica vaginalis.

Ultrasound & color Doppler findings

In a study of 221patients by Vijayaraghavan, the diagnosis of complete type of testicular torsion was made in sixty one patients. Also, incomplete torsion was the diagnosis in four cases. On sonography, there was whirlpool sign present in spermatic cord and on the Doppler study there was absent flow. The whirlpool sign was considered when tortuosity of the spermatic cord was present in view of short axis along with cord rotation above tortuosity level. Also it was described that whirlpool appearance was comparable to doughnut, storm on map of weather, snail shell or target with concentric rings. Further it was described in cases of complete torsion that there is whirlpool sign with flow absence in distal part of spermatic cord & testis. While in the case of incomplete torsion, there was presence of whirlpool sign on sonography along with variable vascularity in testis on the color Doppler. [48]

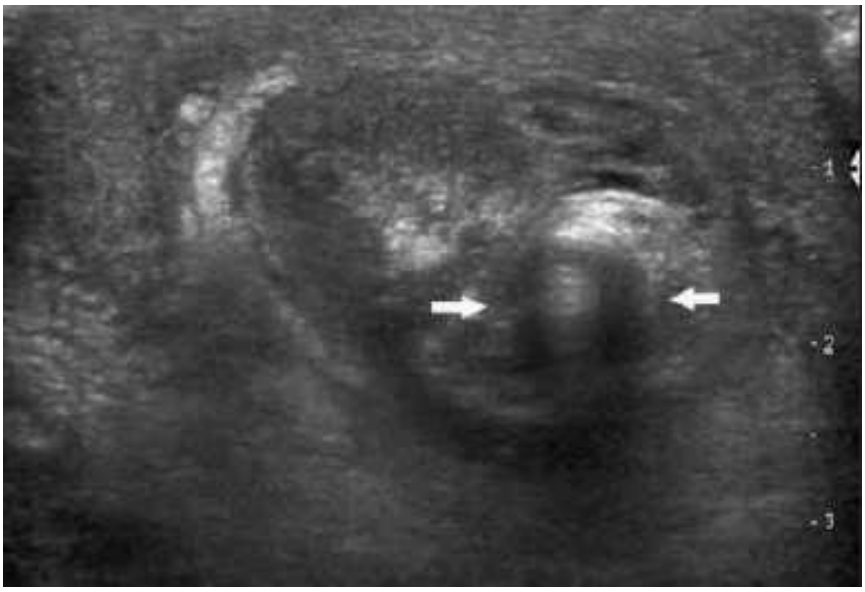


Figure no. 13 showing whirlpool sign on gray scale sonography[48]

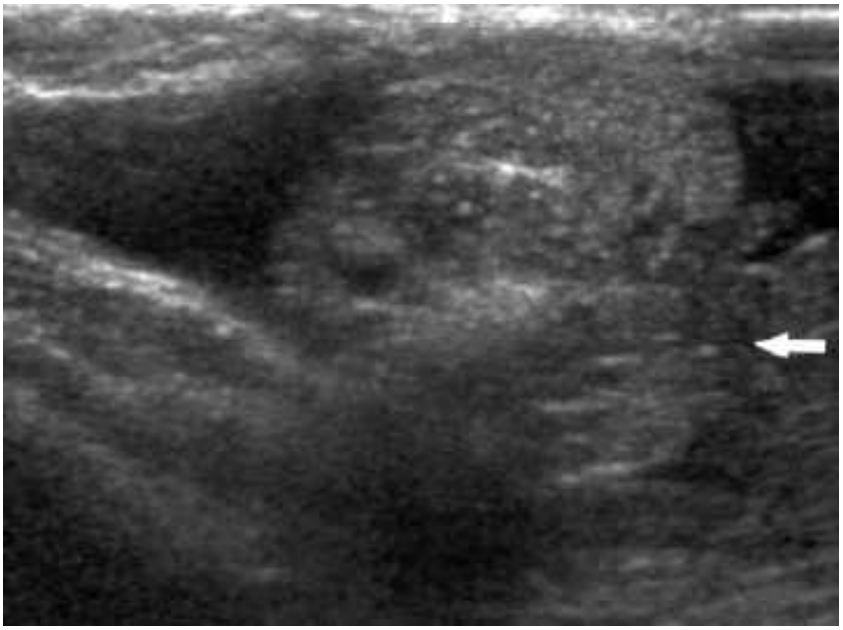


Figure no. 14 showing whirlpool sign on gray scale sonography[48]

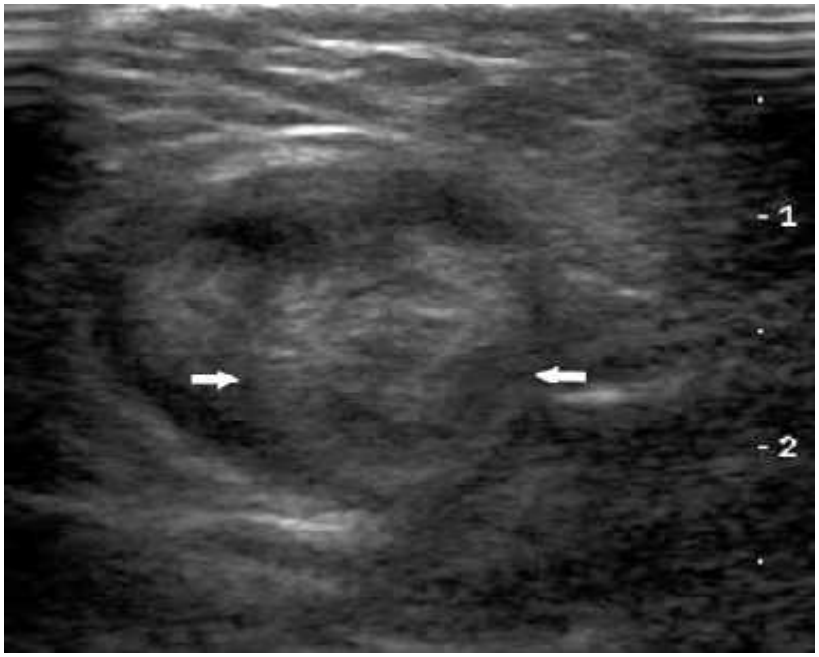


Figure no. 15 showing whirlpool sign on gray scale sonography[48]

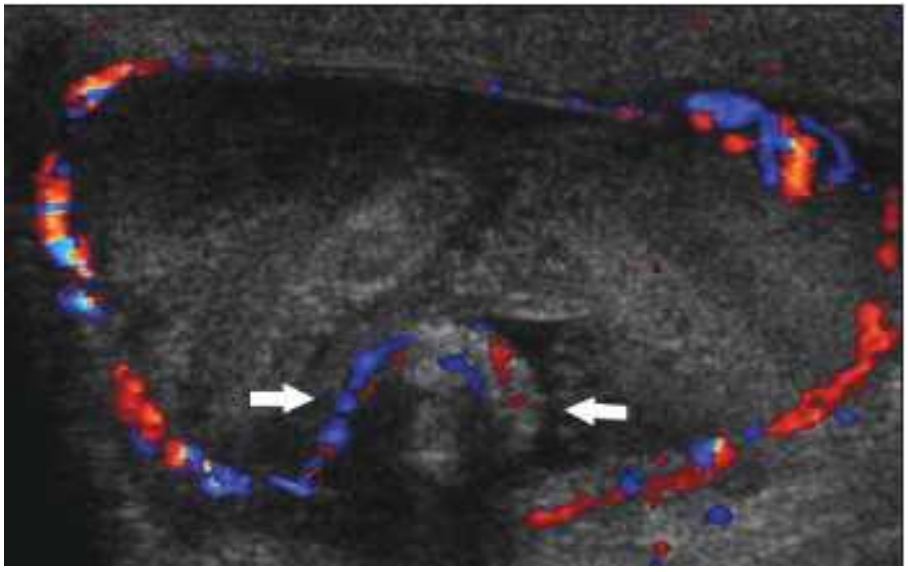


Figure no. 16 showing vascularity present in the proximal part of whirlpool mass[48]

In eleven hospitals of European university, Kalfa et al. found that out of 711 patients 208 were diagnosed with torsion on surgery. On sonography, the finding was presence of mass which was snail shell-shaped in 199 patients (96 %). The size of mass varied from 7 to 33 mm & it represented the actual twist in the spermatic cord. Also, linear cord was present in other acute scrotum cases with 99% specificity. [49]

Yagil et al concluded in a retrospective study of 620 patients of scrotal problems, that there was diagnosis of torsion in 20 cases by using the sonography. The positive finding for the diagnosis was absence of flow in the testis on Doppler examination. Also in two cases, there was hypovascular testis compared to opposite unaffected side.[50]

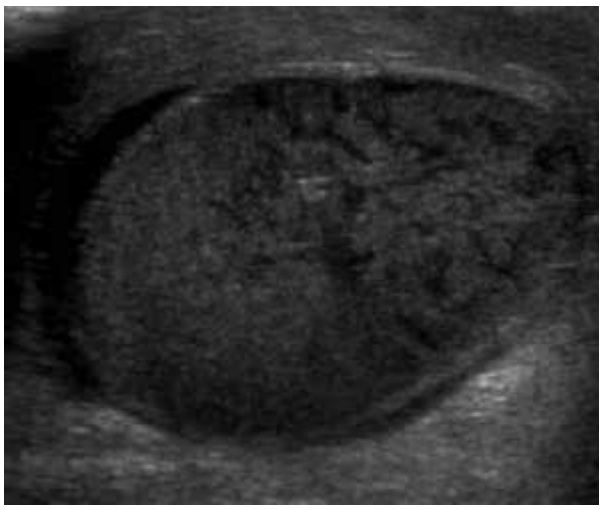


Figure no. 17 showing torsion of testis: hypoechoic & heterogeneous echotexture[50]

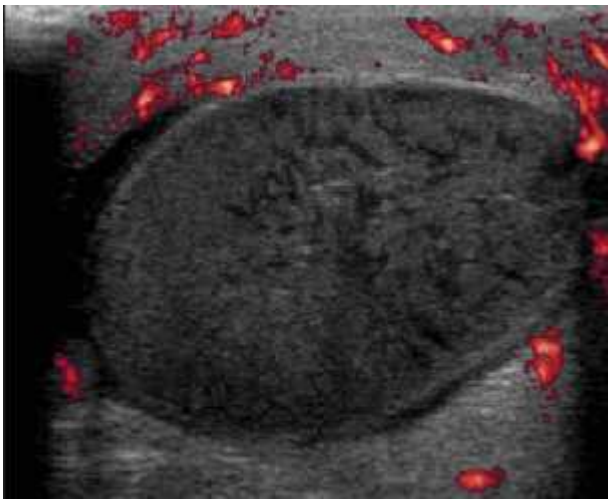


Figure no. 18 showing torsion of testis: Absent testicular vascularity[50]

S A Rizvi et al described in a study of 122 patients with scrotal pathologies, out of which testicular torsion was present in four cases. They concluded torsion by the positive finding of absent testicular flow on Doppler sonography. Also, it was found that sensitivity & specificity of color Doppler ultrasound was100% for scrotum disorders except for testicular masses.[51]

Liang found out 29 cases of torsion in a retrospective study of 342 cases of scrotal examination by using ultrasound. Testicular torsion diagnosis sensitivity and specificity of was 100% and 97.9% on the ultrasound. It was concluded that absence of flow in testis is characteristic feature of torsion. Also, heterogeneous decreased echotexture was another finding in such cases.[52]

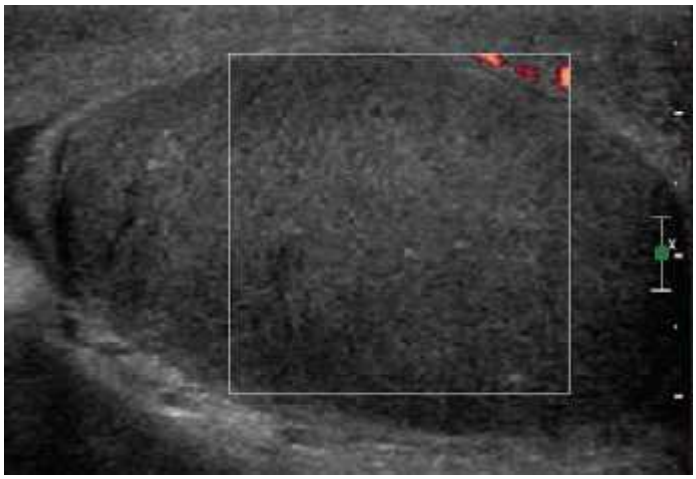


Figure no. 19 showing testicular torsion: Absent testicular vascularity [52]

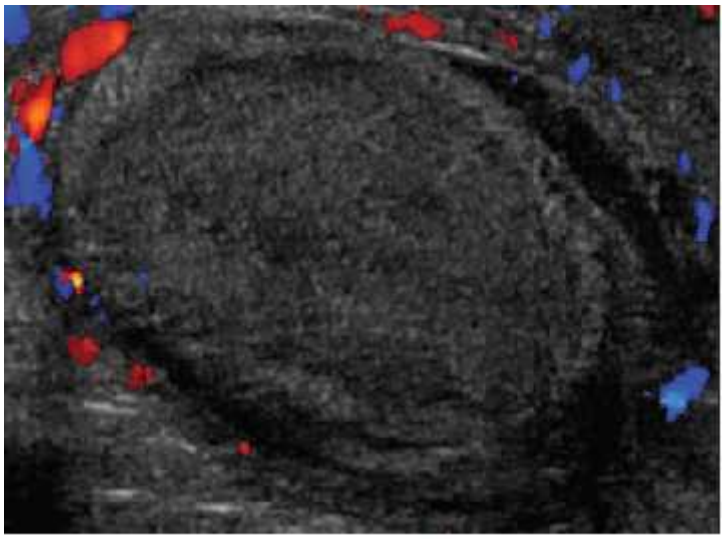


Figure no. 20 showing testicular torsion: Absent testicular vascularity with heterogeneous echotexture[52]

Alfredo D'Andrea et al found in a study 125 patient who presented with scrotal pain that 10 cases were of testicular torsion. On the Gray scale sonography, there was normal echotexture initially. Later on, there was finding of heterogeneous hypoechoic echotexture of testis. It was also further elaborated that torsion refers to twisting of cord from 180° to 720°. The testicular infarction depends upon the amount of twisting.

Diagnosis of complete testicular torsion is made when there is absence of flow on color Doppler examination in the affected testis while contralateral testis shows normal flow. Diagnosis of incomplete torsion comes into effect when twisting of cord is less than that of 360°. In such cases, arterial flow of small magnitude can still be noted in suspected testis. [53]

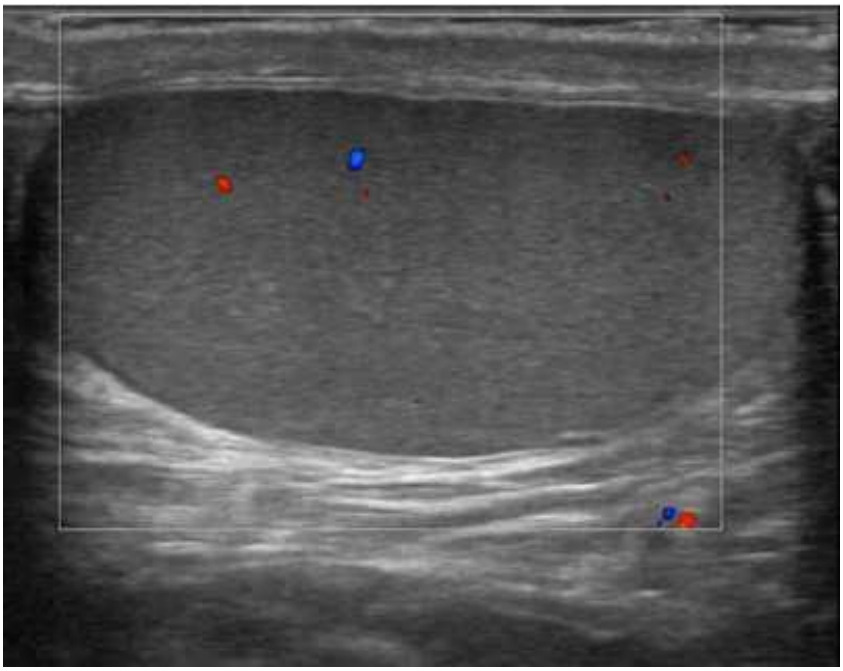


Figure no.21 showing incomplete torsion having minimal vascularity [53]

In a study of 50 patients by A M Agrawal et al, testicular torsion was diagnosed in 8 patients by using color Doppler ultrasound. They concluded the following findings. In the initial situation, testis can be enlarged but echotexture may remain normal & afterwards in late stages testis may be heterogeneous hypoechoic in echogenicity. On Color Doppler, there was absence of flow or significantly less flow as compared to contralateral normal testis. There was 100% sensitivity and specificity for testicular torsion.[54]

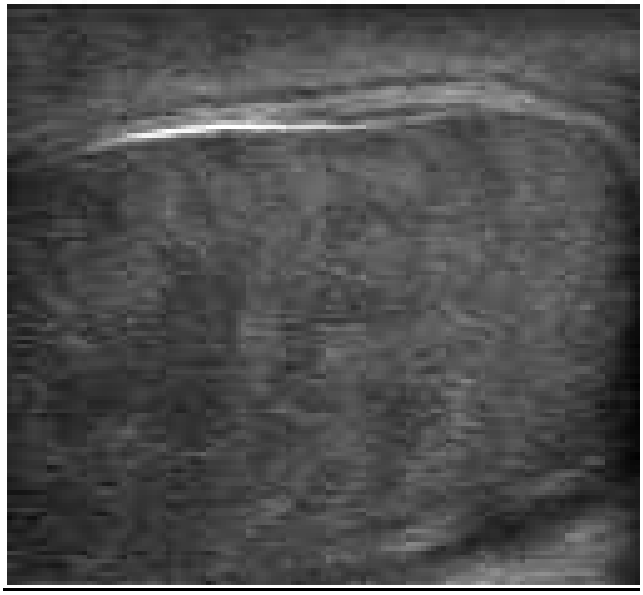


Figure no. 22 showing heterogeneous echotexture on gray scale sonography - torsion case[54]

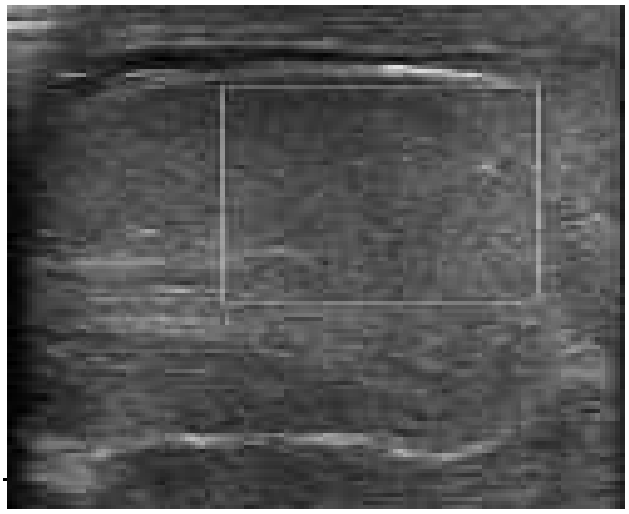


Figure no. 23 showing absent vascularity in testis on color Doppler - torsion case[54]

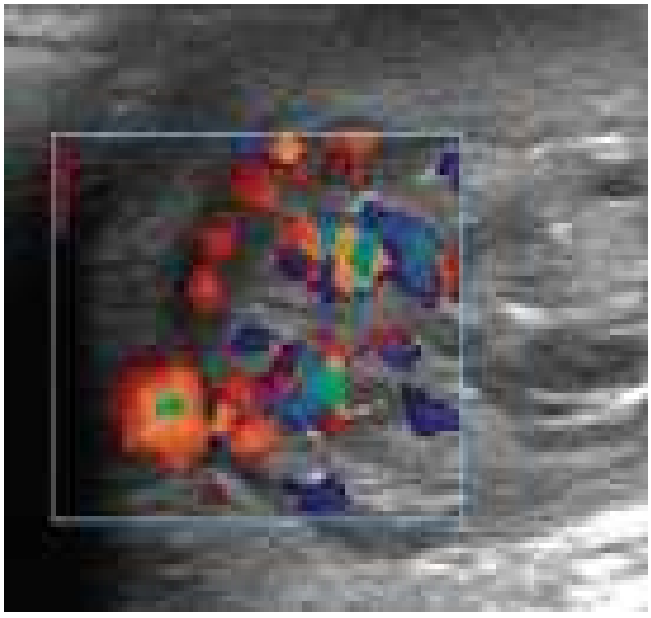


Figure no. 24 showing whirlpool sign - torsion case[54]

Epididymo-orchitis

Introduction

The infectious or inflammatory changes present in epididymis constitute the epididymitis. Urinary tract infection is commonly associated in such cases. These can be noticed in prepubertal boys also. It can further be associated with orchitis.[55]

The younger age group patients which are having epididymo-orchitis may also be having urinary tract anomalies like imperforated anus, hypospadiasis, ectopic ureter & neurogenic bladder.[39,56]

Noske et al. contributed about prehn's sign. Prehn's sign refers to relief of pain in case epididymo-orchitis by testicular elevation, however it is unreliable & non specific.[36]

Bacterial infections are predominantly responsible for epididymo-orchitis. These basically ascend in retrograde fashion from urinary tract. In males less than 35 years of age with active sexual life, common infective organisms are Neisseria gonorrhoeae and Chlamydia trachomatis. In the paediatric age group and in patients more than 35 years of age without significantly active sexual life, common infective organism is Escherichia coli.[57]

Incidence: The incidence of epididymo-orchitis is approximately 0.69 percent in the outpatient department in the age group of 18 to 50 years. Approximately one out of 144 patients is affected.[58]

Ultrasound & color Doppler findings

W D Middleton et al. concluded that there is increased flow on Doppler in the affected testis & epididymis in comparison to unaffected opposite side. There is almost 100% sensitivity.[59]

Horstmanetal found that on color Doppler, the most important & reliable feature for diagnosis of epididymo-orchitis is that of increased blood flow or hypervascularity. Sometimes, it is the only positive finding in the patient.[60]

In a study by Vijayaraghavan, the diagnosis of epididymo-orchitis was established in 65 patients out of 221 who presented with complaint of acute pain in scrotum. The positive finding which contributed to the diagnosis was the straight spermatic cord. This sign helped to differentiate from testicular torsion in which whirlpool sign was diagnostic.

Other finding was of swollen or enlarged testis or epididymis or both. Also, there was absence of mass lesion in testis. Hydrocele was not a consistent feature. It was present in some cases while absent in others. On color Doppler, there was significantly increased flow in the affected side which again was an important parameter for diagnosis.[48]

Thinyu et al. found out in a study of 110 patients, that 84 patients presented with pain and 52 cases were diagnosed with infection. It was further concluded infection was the most common etiological factor for pain in scrotum. From diagnostic view, the positive findings were hypoechoic heterogeneous echotexture of testis with increased vascularity in testis & epididymis.[61]

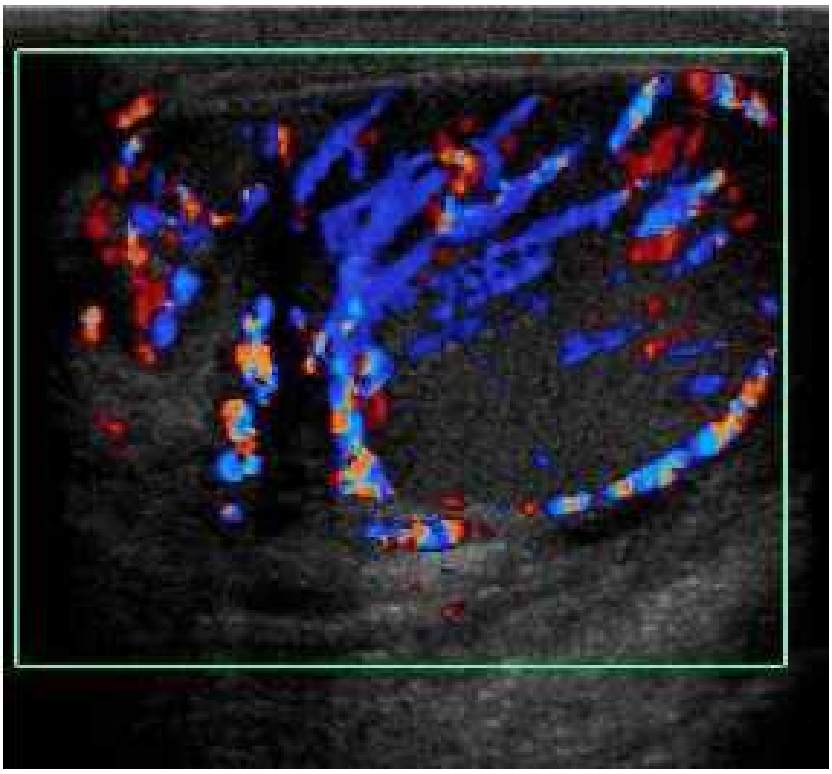


Figure no. 25 showing increased vascularity: epididymo-orchitis case [61]

S A Rizvi conducted study in 122 patients having scrotal problems. The diagnosis of epididymo-orchitis or epididymitis was made in the 23 patients out of the 26 patients who presented with acute pain. The positive features for the diagnosis were enlarged epididymis along with hypoechoic echotexture. Also, the hyperemia was a consistent feature represented as increased flow on color Doppler study. Sensitivity & specificity both were 100% for the patients of scrotal pathologies except for mass lesion of testis.[51]

In a study of 164 patients by Alfredo D'Andrea et al, there were 125 patients who presented with scrotal pain, out of which 72 had infection. Most prevalent etiological factor of acute scrotum was found out to be infection especially in middle-aged patients.

The positive features contributing to diagnosis were increased size of epididymis or testis or both along with heterogeneous echotexture. The affected epididymis and testis had hyperemia which manifested as increased flow on color doppler. Frequently, there was involvement of head of epididymis. Changes in size and echogenicity were variable features which modified along the course of disease. Other associated findings were hydrocele & thickening of wall. [53]

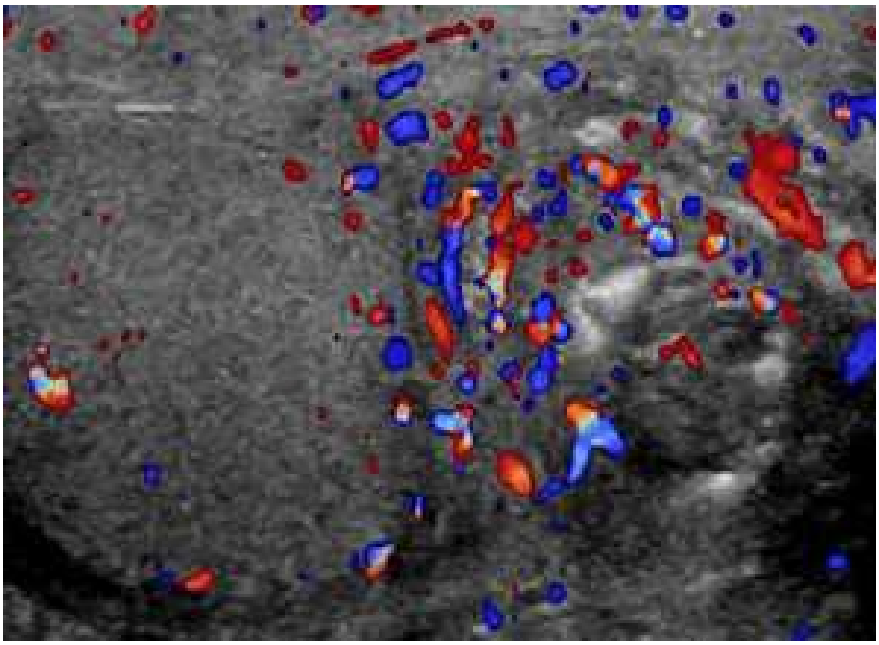


Figure no. 26 showing increased vascularity at epididymal head[53]

A M Agrawal et al concluded in a study that 33 cases out of 50 patients had epididymo-orchitis by using color Doppler ultrasonography. The positive findings were thickening and increase in size of epididymis. Echotexture was variable, along with heterogeneity in nature. Testis was also involved in some cases, predominantly hypoechoic in echotexture & in majority of cases diffusely affected. On color Doppler, the positive feature was increased flow on the affected side involving either epididymis or testis or both. Two cases were false positive out of 33 cases. The correct diagnosis was omental hernia & varicocele in these cases. Specificity was 85.7% and sensitivity was 86.1% for diagnosis of epididymo-orchitis. [54]

Hernia

Introduction

The term of hernia refers to the protrusion of a part or structure through the tissues normally containing it.[62] If bowel loops or omentum or both traverse down into inguinal canal & then into scrotum, this is termed as inguino-scrotal hernia.[63] If only fluid is present in the scrotal region, then it is known as hydrocele. In such cases, findings will be of scrotal swelling & pain. Also sometimes vomiting & nauseas can be a feature. In case of incarcerated hernia, there will be scrotal fullness. Pain with palpable mass is the clinical feature.

Incidence: The incidence rate is 4.5% for inguino-scrotal hernia in the paediatric age group. Also there is 29.7% rate for strangulation of inguinal hernia.[64]

Types [65]

There are two types of hernia -

1. Indirect type
2. Direct type

Indirect hernia: In this type, the contents come out of abdomen through internal inguinal ring lateral to inferior epigastric vessel then travel through inguinal canal and lastly reach into the scrotum. These are commonly found in paediatric age group. Also, there is an association of indirect hernias with patent processus vaginalis.

Direct hernia: In this type, contents come through inguinal canal posterior wall in which there is an area of weakness. This part is known as Hesselbach's triangle. The medial side of triangle is bounded by rectus sheath. The lateral border is bounded by inferior epigastric artery. Inferior boundary is by the inguinal ligament. Such hernias are frequent in adults.

Ultrasound & color Doppler findings

Ogata et al concluded that by utilizing ultrasound, strangulated hernia could be correctly diagnosed in 35 out of 39 patients. The positive finding was that of akinetic loop which was dilated and could be visualised in real-time sonography. Sensitivity was 90% & specificity was 93% for the diagnosis of strangulated hernia.[66]

Celestino et al. found out 40 cases of inguinal hernia in sample size of 750 patients with scrotum pathologies. Sonographic finding was that scrotum contained round shaped structures which could be more than one in number & there was presence of either bubbles of air or fluid within them. Movement of either air bubble or fluid in the intestinal loop was diagnostic of hernia. Omentum was seen as echogenic structure. There was one case out these 40 cases which was diagnosed as strangulated hernia. The diagnostic positive finding was of dilated akinetic loop of intestine. [63]

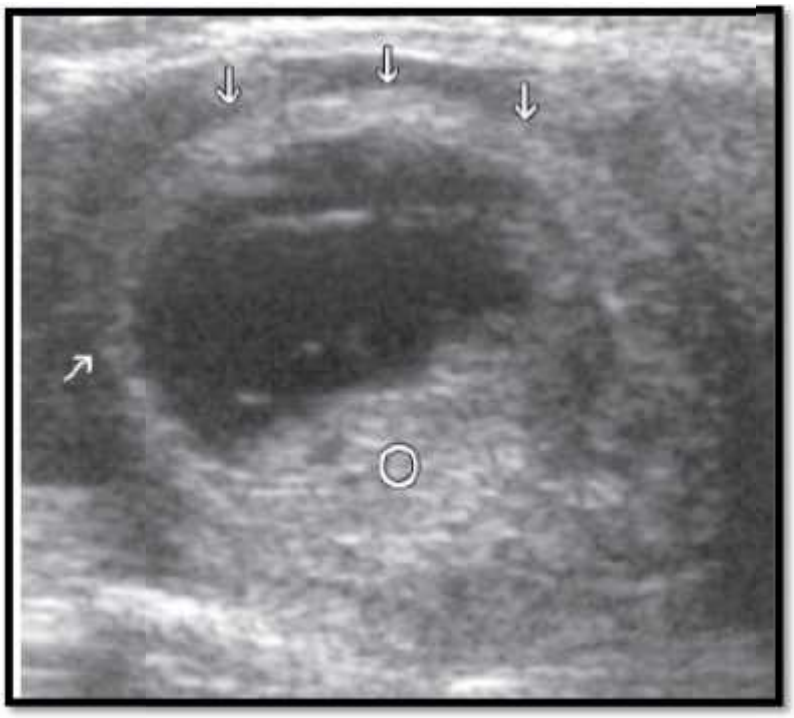


Figure no. 27 showing inguinoscrotal hernia with circular configuration. [63]
O- omentum present as echogenic area
Arrows – Inguinoscrotal hernia

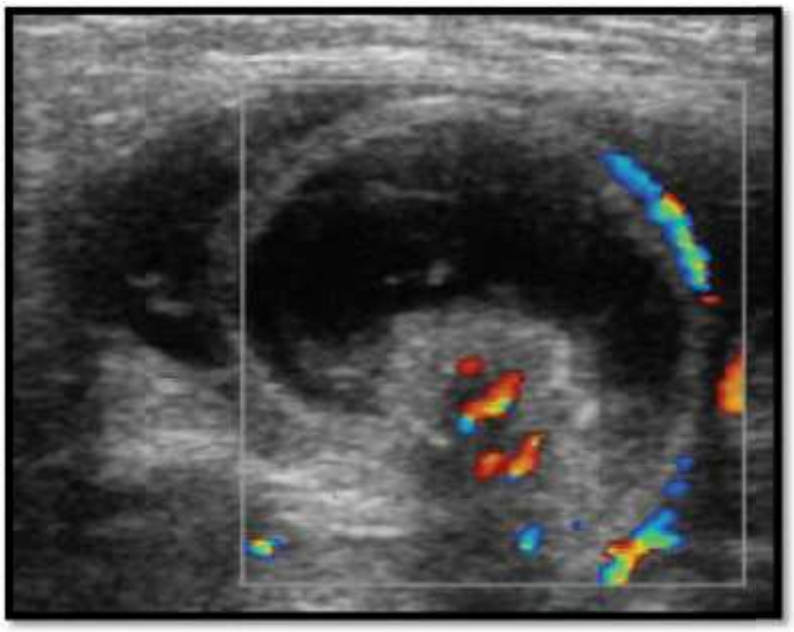


Figure no. 28 showing inguinoscrotal hernia on color Doppler examination [63]

Yagil et al. in a study of 620 patients found 8 patients of inguinal hernia which were indicated for surgical exploration. Findings were of intestinal loops present in inguino-scrotal region. [50]

G. T. Yusuf described that on Ultrasound, inguino-scrotal hernia can be diagnosed if bowel loops or omentum are visualized in scrotum. On Grey scale sonography, bowel loops or omentum can be seen. Omentum appears echogenic area while bowel appears as round or oval loops. Also, intestinal peristalsis or movement again further suggests hernia.[1]

In a study of 125 patients with scrotal pain by Alfredo D'Andrea et al, 5 patients were diagnosed with hernia. The positive finding was fluctuation or motion of either air bubble or else there was peristalsis of bowel which was clearly noticed in real time sonography. Omentum was noticed as significantly echogenic area. It was also concluded that four patients were having strangulated hernia. The diagnostic finding was dilated akinetic bowel loop which actually represents strangulation due to reduced vascularity & thus reduced or absent peristalsis. Also, in some cases, there was altered flow to testis. [53]

A M Agrawal et al found out one case of obstructive inguino-scrotal hernia in 50 patients case study. Pain & swelling were the presenting symptoms. Bowel loop was visualized in the scrotum as air or fluid filled structure. Omentum was an echogenic structure. Strangulation showed non peristaltic bowel loop or akinetic loop.[54]

Varicocele

Introduction

R Feld & WD Middleton explained the varicoceles correspond to dilatation of the pampiniform plexus predominantly due to ineffective valves of veins.

These are of two types.

1. Primary varicocele
2. Secondary varicocele

In primary varicocele, the predominant pathology is regarding incompetent valves, due to which a significant back flow or reflux occurs into the pampiniform plexus. This reflux leads to varicocele formation. The disease entity of varicocele is frequent on the left side. The reason being that there is drainage of blood from left internal spermatic vein into left renal vein at ninety degrees, hence back pressure changes are more evident. While on the right side, right spermatic vein drains into IVC directly at acute angle. Also, there is negative pressure due to caval flow which facilitates drainage. In secondary varicocele, the predominant pathology is regarding significantly increased pressure of veins of testis. Etiological factors contributing to these are portal hypertension, hydronephrosis and abdominal space occupying lesions. Also, nut cracker syndrome can be a causative agent in which left renal vein is compressed between aorta & SMA.[67]

Incidence: The incidence of varicocele has been found maximum to 13% in males who are non-symptomatic. In the infertile males group, high incidence of 40% has been reported [68]

Ultrasound & color Doppler findings

On gray scale ultrasound, there is serpiginous appearance of varicoceles. They are tubular structures with predominantly anechoic echotexture. The diameter is usually greater than 2 mm.

There is increase in size on valsalva maneuver and also reflux of flow can be demonstrated.[25,68]

Dogra et al. considered gold standard modality for diagnosis of varicocele to be color Doppler ultrasound. Sensitivity and specificity approached near to 100% in these cases.[21]

In a study of 110 patients by Thinyu et al, 84 patients presented with pain and 10 cases were diagnosed with varicocele. Dilated venous channels were the primary findings. [61]

Yagil et al. in a study of 620 patients found that 107 cases were diagnosed with varicocele however only 20 cases required urgent attention and were hospitalized. Remaining cases were not in urgent need of intervention. [50]

S A Rizvi et al. in a study of 122 patients diagnosed 14 cases of varicocele.

Eight cases were diagnosed with unilateral varicocele while six cases were affected bilaterally.

The positive finding for the diagnosis was anechoic serpiginous areas which were multiple in numbers. These were near to testicular upper pole & also nearby to epididymal head.

On performing the valsalva, there was increased venous flow. Similar increased flow was noted if patient was asked to stand in upright position.[51]

Pauroso et al, in a study of 95 patients found out 41 cases of varicocele. Out of total 41 cases, 38 cases were diagnosed first time while three cases were repetitive type.[69]

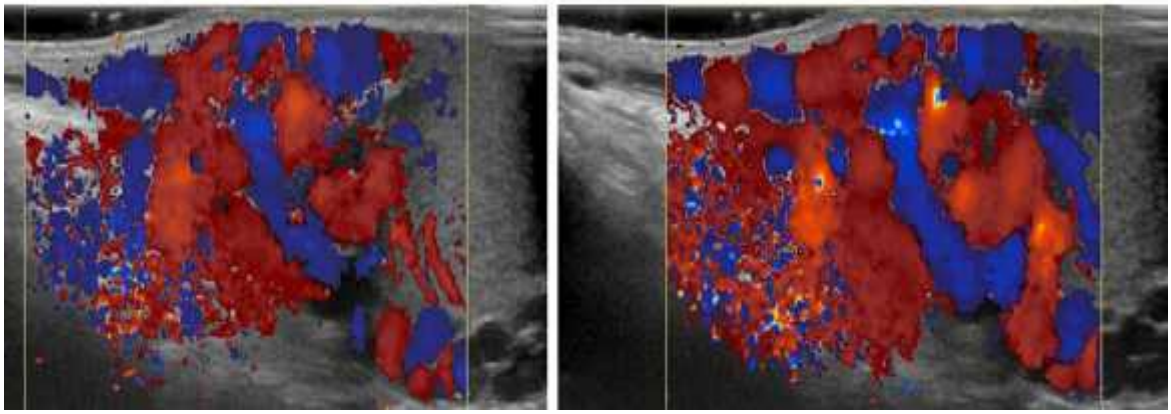


Figure no. 29 showing varicocele at rest & then increase in size during valsalva[69]

Alfredo D'Andrea et al found in a study of 125 patients with scrotal pain that 18 were having varicocele. The positive finding was of enlarged venous channels. Such channels were anechoic in echotexture while shape was tortuous, irregular & tubular. Venous flow was present in these channels. Valsalva maneuver showed increased flow. [53]

RESULTS

Table no.1 : Distribution of cases according to diagnosis

DIAGNOSIS	**N**	**%**
EPIDIDYMO-ORCHITIS	36	72
INCARCERATED HERNIA	2	4
TORSION	5	10
VARICOCELE	7	14
Total	50	100

Table No. 2 : Distribution of cases according to age

AGE (YRS)	**N**	**%**
1-10	4	8
11-20	7	14
21-30	17	34
31-40	8	16
41-50	5	10
>50	9	18
Total	50	100

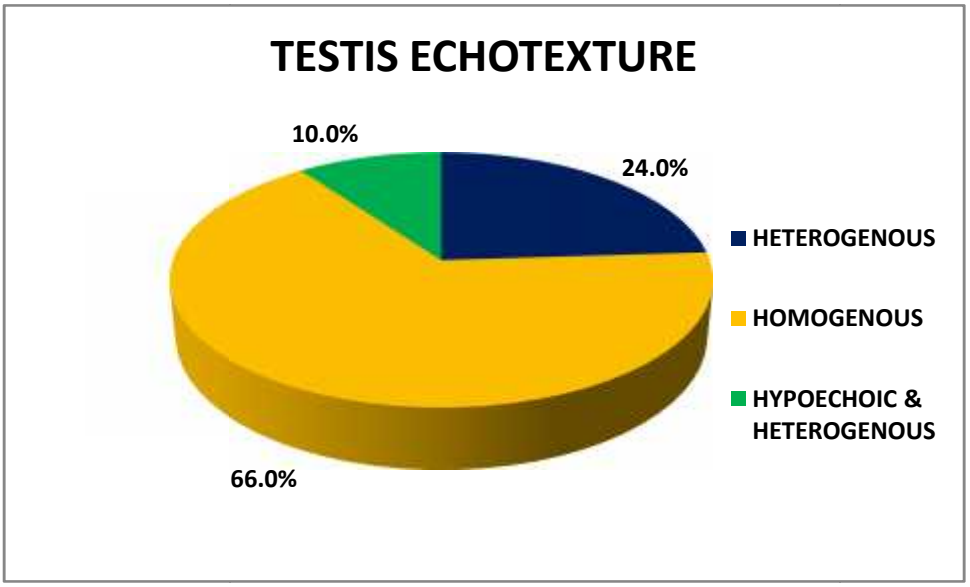


Figure no. 30 : Distribution of cases according to testis echotexture

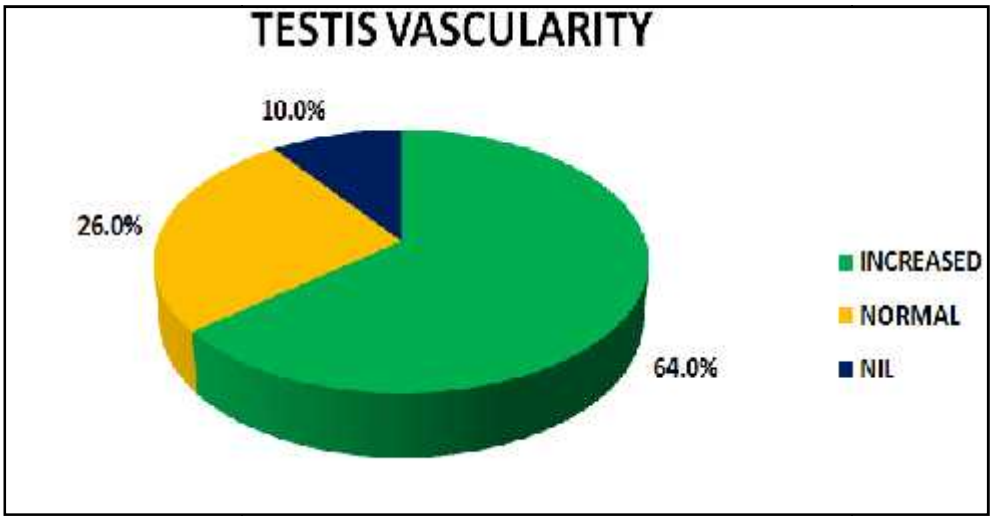


Figure no. 31 : Distribution of cases according to testis vascularity

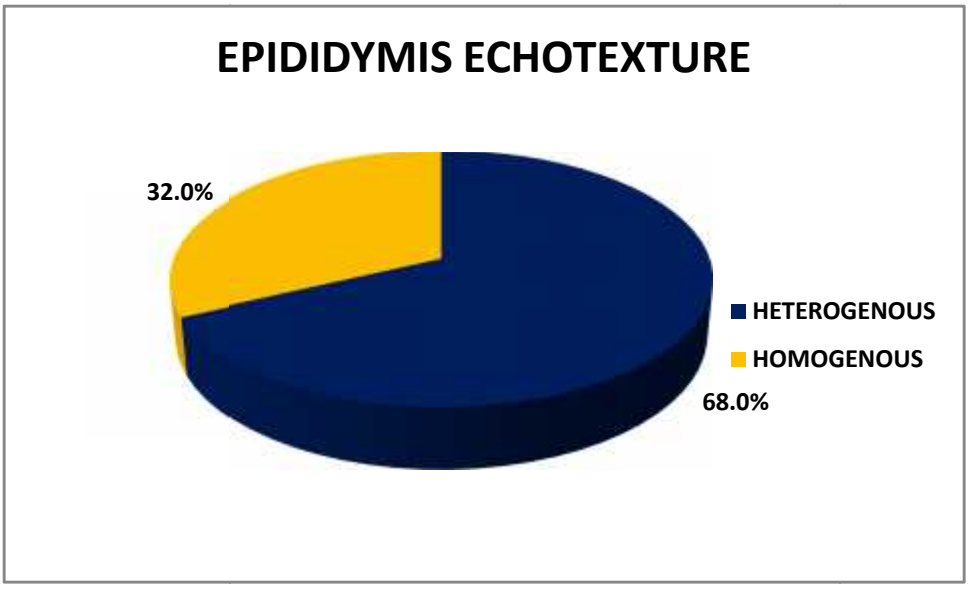


Figure no. 32 : Distribution of cases according to epididymis echotexture

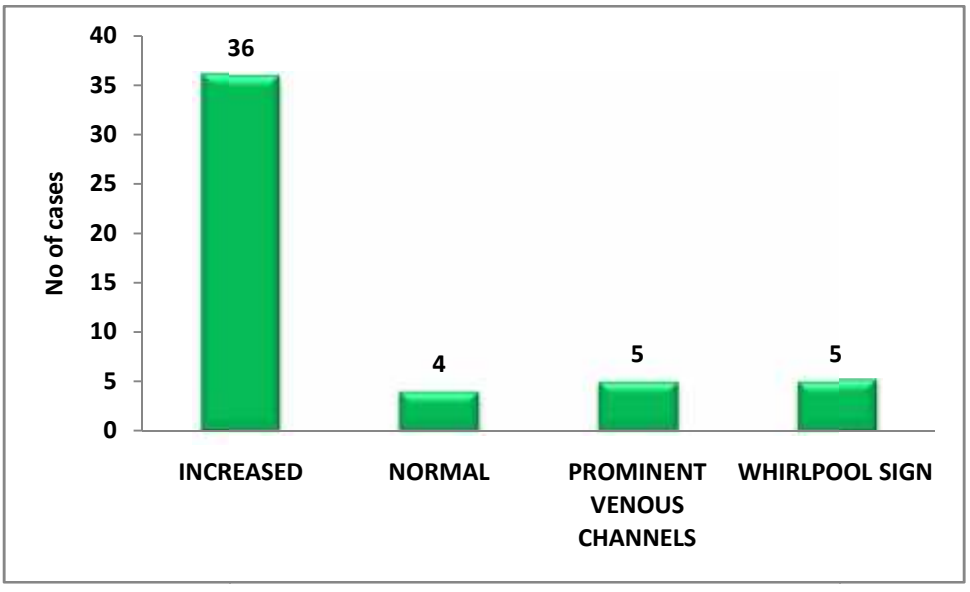


Figure no. 33: Distribution of cases according to epididymis vascularity

Table no.3 : ASSOCIATION OF DIAGNOSIS AND AGE

AGE (YRS)	EPIDIDYMO-ORCHITIS		INCARCERATED HERNIA		TORSION		VARICOCELE		p value
	N	%	N	%	N	%	N	%	
1-10	3	8.3	0	0.0	1	20.0	0	0.0	
11-20	5	13.9	0	0.0	2	40.0	0	0.0	
21-30	12	33.3	1	50.0	1	20.0	3	42.9	
31-40	7	19.4	0	0.0	1	20.0	0	0.0	0.082
41-50	1	2.8	1	50.0	0	0.0	3	42.9	
>50	8	22.2	0	0.0	0	0.0	1	14.3	
Total	36	100.0	2	100.0	5	100.0	7	100.0	

Table no.4: ASSOCIATION OF DIAGNOSIS AND SYMPTOMS

SYMPTO-MS	EPIDIDYMO-ORCHITIS		INCARCERATED HERNIA		TORSION		VARICOCELE		p value
	N	%	N	%	N	%	N	%	
PAIN	36	100.0	2	100.0	5	100.0	7	100.0	-
SWELLING	6	16.7	2	100.0	4	80.0	6	85.7	<0.001
ERYTHEMA	13	36.1	0	0.0	1	20.0	0	0.0	0.205

Table no.5: ASSOCIATION OF DIAGNOSIS AND AFFECTED TESTIS SIZE IN AGE ≤20YRS

Affected testis size (in mm)	EPIDIDYMO-ORCHITIS		INCARCERATED HERNIA		TORSION		VARICOCELE		p value
	N	%	N	%	N	%	N	%	
≤30	3	37.5	0	0.0	1	33.3	0	0.0	0.709
31-50	2	25.0	0	0.0	2	66.7	0	0.0	
>50	3	37.5	0	0.0	0	0.0	0	0.0	
Total	8	100.0	0	0.0	3	100.0	0	0.0	

Table no.6: ASSOCIATION OF DIAGNOSIS AND AFFECTED TESTIS SIZE IN AGE >20YRS

Affected Testis Size (in mm)	EPIDIDYMO-ORCHITIS		INCARCERATED HERNIA		TORSION		VARICOCELE		p value
	N	%	N	%	N	%	N	%	
≤30	0	0.0	0	0.0	0	0.0	0	0.0	0.018
31-50	7	25.0	2	100.0	4	80.0	2	28.6	
>50	21	75.0	0	0.0	0	0.0	5	71.4	
Total	28	100.0	2	100.0	5	100.0	7	100.0	

Table no.7: ASSOCIATION OF DIAGNOSIS AND TESTIS ECHOTEXTURE

TESTIS ECHOTEXTURE	EPIDIDYMO-ORCHITIS		OBSTRUCTED HERNIA		TORSION		VARICOCELE		p value
	N	%	N	%	N	%	N	%	
HETEROGENOUS	11	30.6	0	0.0	1	20.0	0	0.0	<0.001
HOMOGENOUS	24	66.7	2	100.0	0	0.0	7	100.0	
HYPOECHOIC & HETEROGENOUS	1	2.8	0	0.0	4	80.0	0	0.0	
Total	36	100.0	2	100.0	5	100.0	7	100.0	

Table no.8: ASSOCIATION OF DIAGNOSIS AND TESTIS VASCULARITY

TESTIS VASCULARITY	EPIDIDYMO-ORCHITIS		OBSTRUCTED HERNIA		TORSION		VARICOCELE		p value
	N	%	N	%	N	%	N	%	
INCREASED	32	88.9	0	0.0	1	20.0	0	0.0	<0.001
NORMAL	4	11.1	2	100.0	0	0.0	7	100.0	
NIL	0	0.0	0	0.0	4	80.0	0	0.0	
Total	36	100.0	2	100.0	5	100.0	7	100.0	

In this table, the epididymo-orchitis group includes the 4 cases of epididymitis in which testis vascularity was normal.

Table no .9: ASSOCIATION OF DIAGNOSIS AND EPIDIDYMIS ECHOTEXTURE

EPIDIDYMIS ECHOTEXTURE	EPIDIDYMO-ORCHITIS		OBSTRUCTED HERNIA		TORSION		VARICOCELE		p value
	N	%	N	%	N	%	N	%	
HETEROGENOUS	29	80.6	0	0.0	5	100.0	0	0.0	<0.001
HOMOGENOUS	7	19.4	2	100.0	0	0.0	7	100.0	
Total	36	100.0	2	100.0	5	100.0	7	100.0	

Table no.10: ASSOCIATION OF DIAGNOSIS AND EPIDIDYMIS VASCULARITY

EPIDIDYMIS VASCULARITY	EPIDIDYMO-ORCHITIS		OBSTRUCTED HERNIA		TORSION		VARICOCELE		p value
	N	%	N	%	N	%	N	%	
INCREASED	36	100.0	0	0.0	0	0.0	0	0.0	<0.001
NORMAL	0	0.0	2	100.0	0	0.0	2	28.6	
PROMINENT VENOUS CHANNELS	0	0.0	0	0.0	0	0.0	5	71.4	
WHIRLPOOL SIGN	0	0.0	0	0.0	5	100.0	0	0.0	
Total	36	100.0	2	100.0	5	100.0	7	100.0	

IMAGING GALLERY

CASE 1 Torsion of Testis

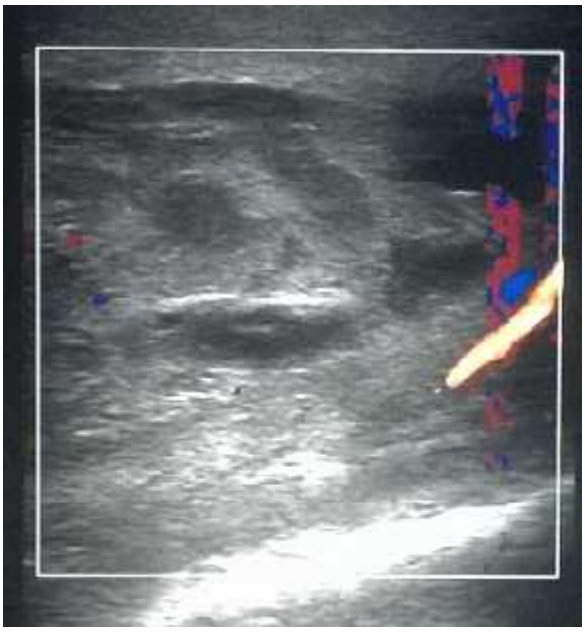


Figure no. 34 showing Whirlpool Sign with twisting vessels.

Figure no. 35 showing absence of vascularity in testis.

To conclude: whirlpool sign present with no significant color flow distal to it. Diagnosis of spermatic cord torsion.

CASE 2 TORSION

Figure no. 36 showing Whirlpool Sign – twisting appearance

Figure no. 37 showing Whirlpool Sign.

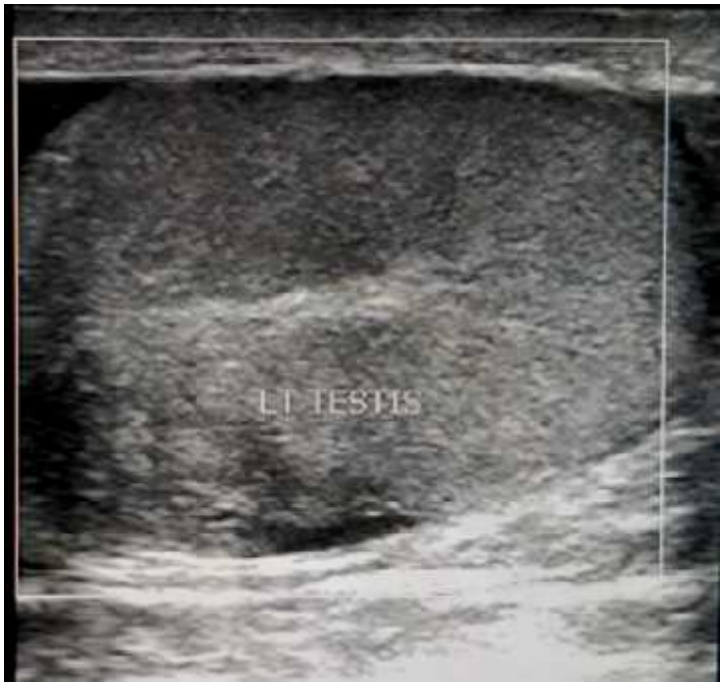


Figure no. 38 showing absent intratesticular vascularity.

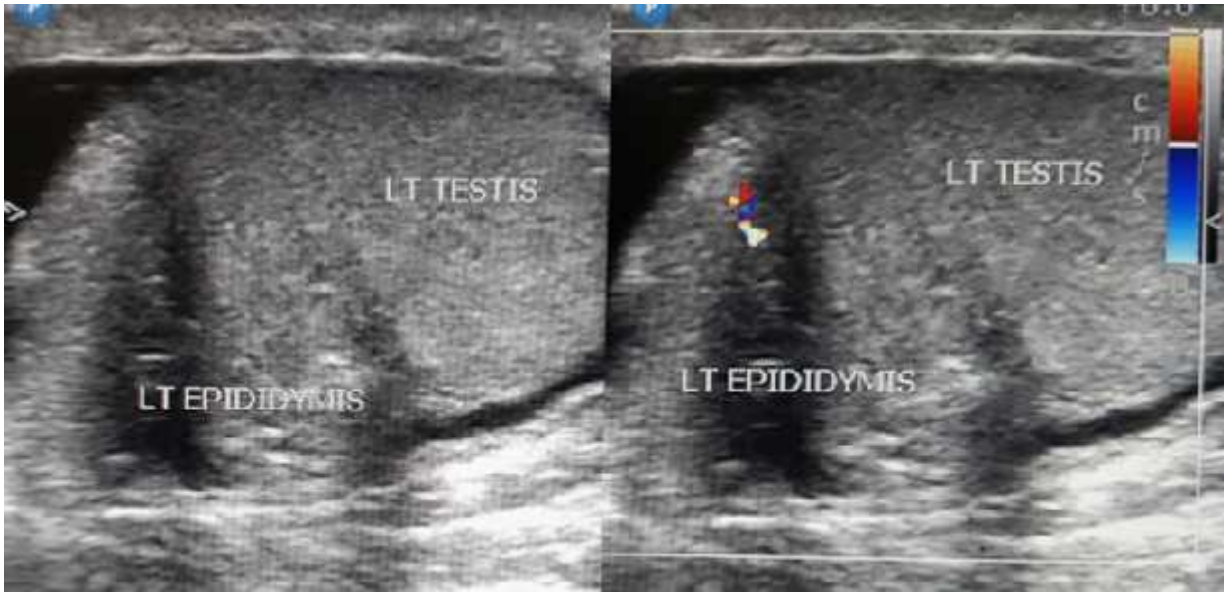


Figure no. 39 showing non-significant vascularity in the testis. Epididymis was bulky.

Conclusion: Whirlpool sign present with no significant color flow distal to it. Diagnosis of spermatic cord torsion.

CASE 3 TORSION

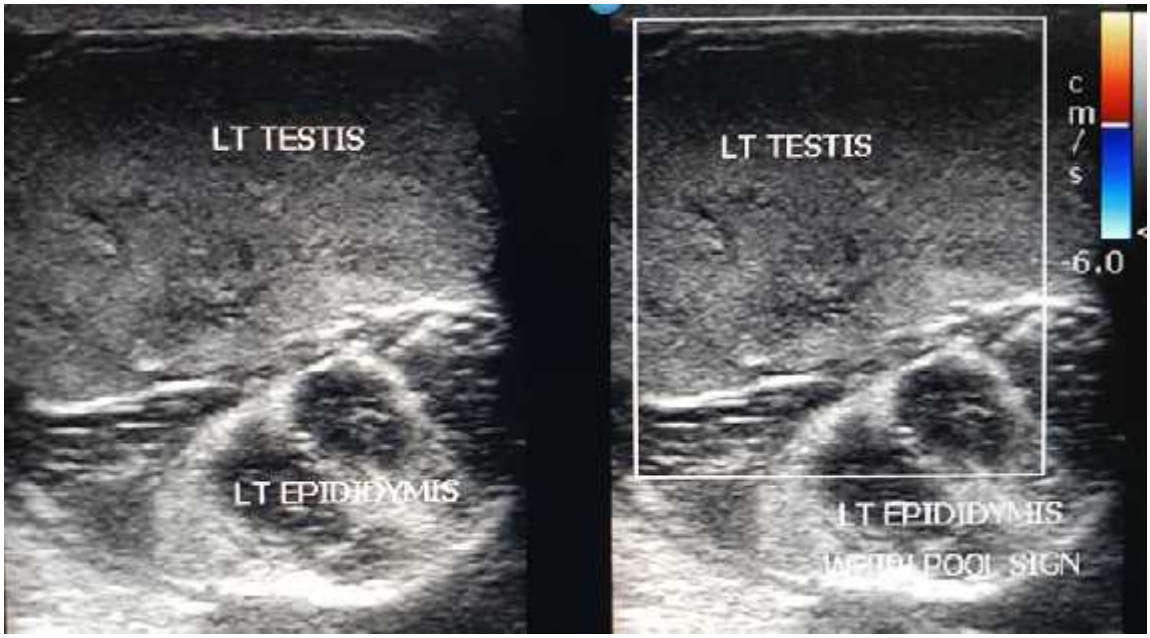


Figure no. 40 Whirlpool sign: On gray scale, there is heterogeneous echotexture of testis. Epididymis is enlarged bulky with twisting of vessels-.

On color Doppler image, no significant vascularity in the depicted part.

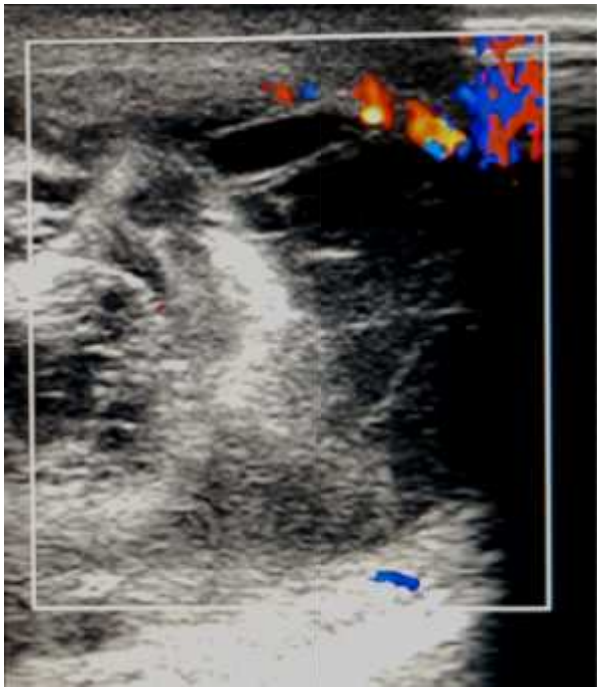


Figure no. 41 & 42

On color Doppler image, no significant vascularity in the region distal to whirlpool sign.

Diagnosis of spermatic cord torsion.

CASE 4 Epididymo-orchitis

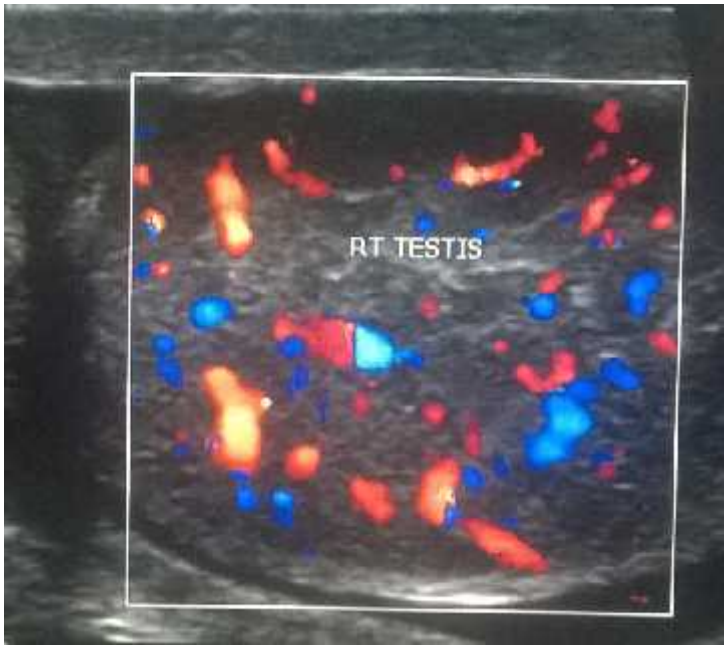


Figure no. 43

On color Doppler image, increased testicular vascularity

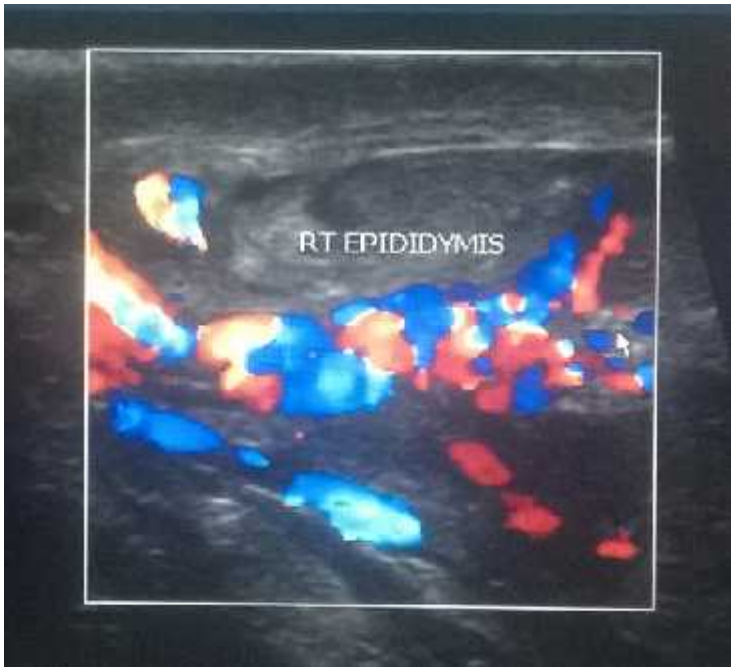


Figure no. 44

On color Doppler image, increased epididymal vascularity

Case 5 Epididymo-orchitis

Figure no. 45

On gray scale image, heterogeneous echotexture of testis.

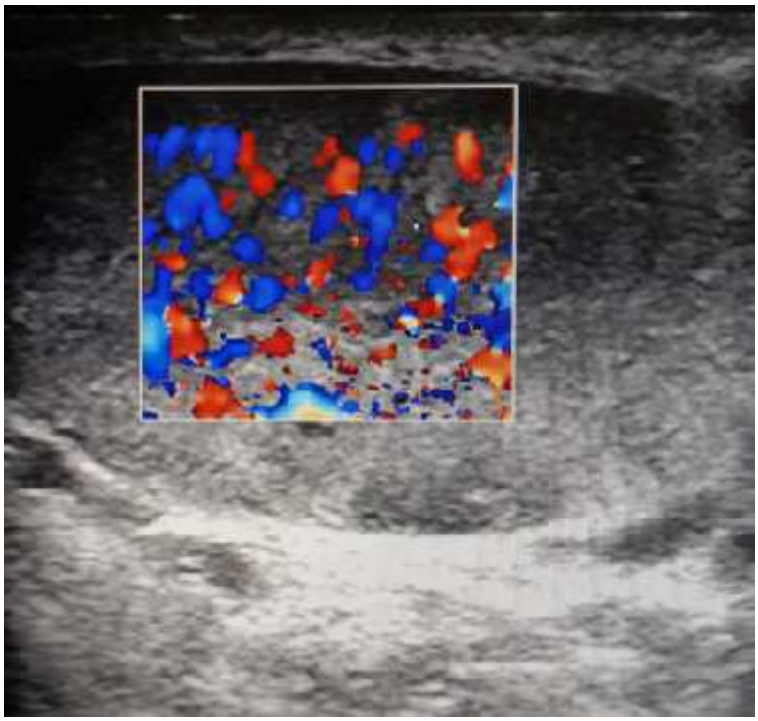


Figure no. 46

On color Doppler image, hypervascular testis.

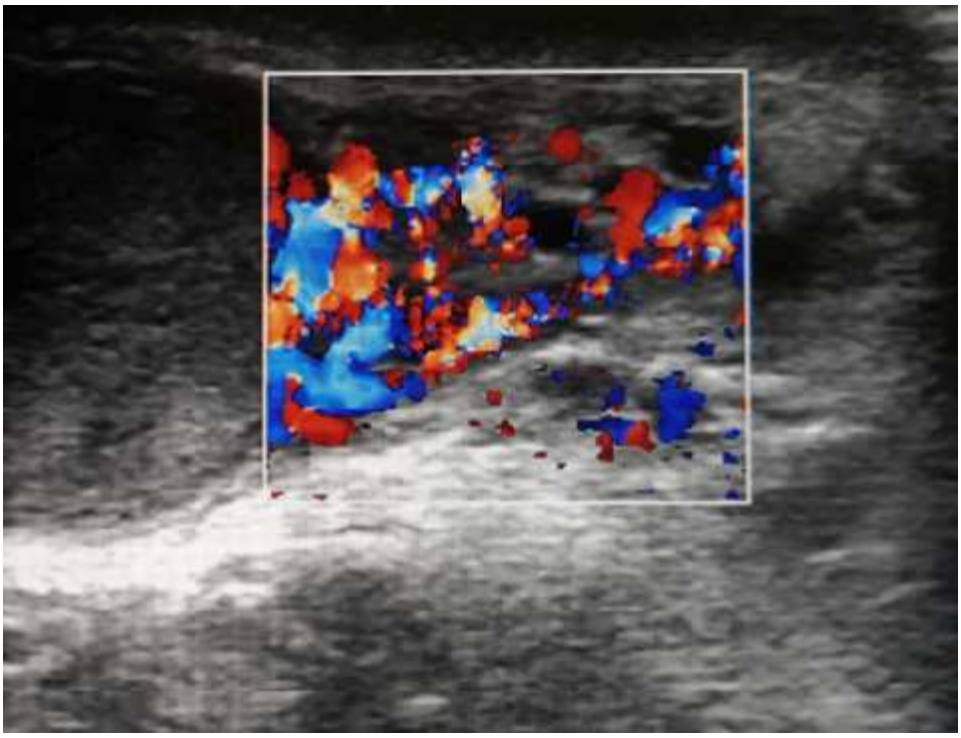


Figure no. 47

On color Doppler image, increased vascularity in epididymis & testis.

To conclude for the case: Heterogenous & hypervascular testis with significantly increased vascularity in epididymis.

Diagnosis of epididymo-orchitis.

Case 6 Epididymo-orchitis

Figure no.48

On gray scale image, enlarged bulky epididymis.

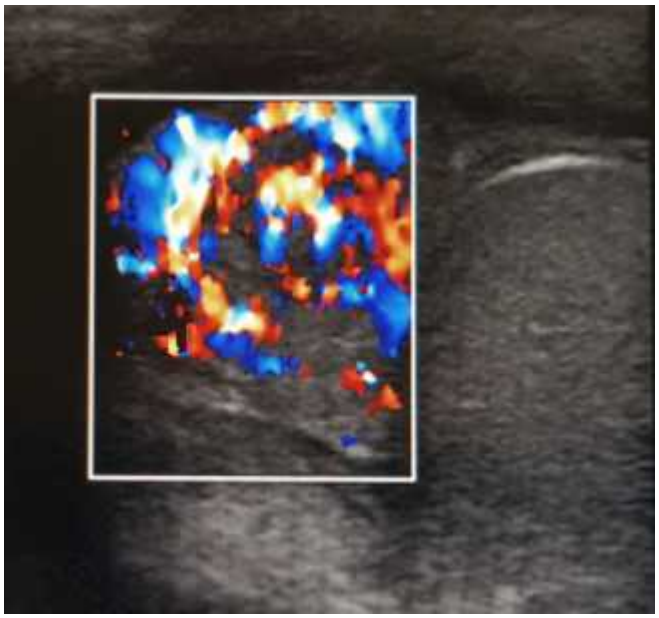


Figure no.49

On color Doppler image, epididymis shows increased vascularity.

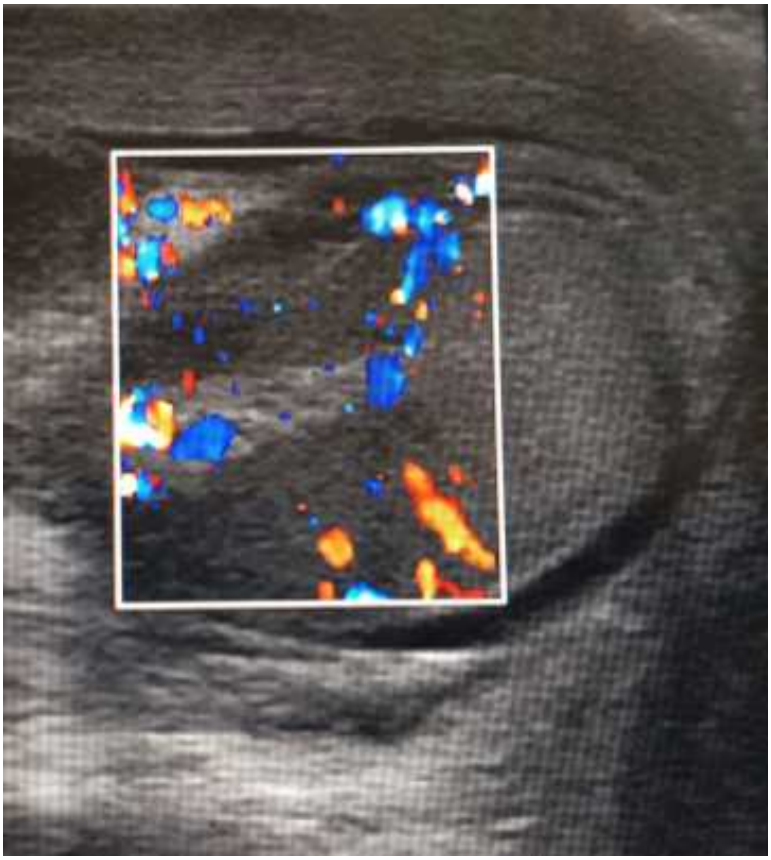


Figure no.50

On color Doppler image, testis shows increased vascularity.

So to conclude for the last three figure- enlarged & hypervascular epididymis with increased vascularity of testis.

Diagnosis of epididymo-orchitis.

Case 7 Epididymo-orchitis

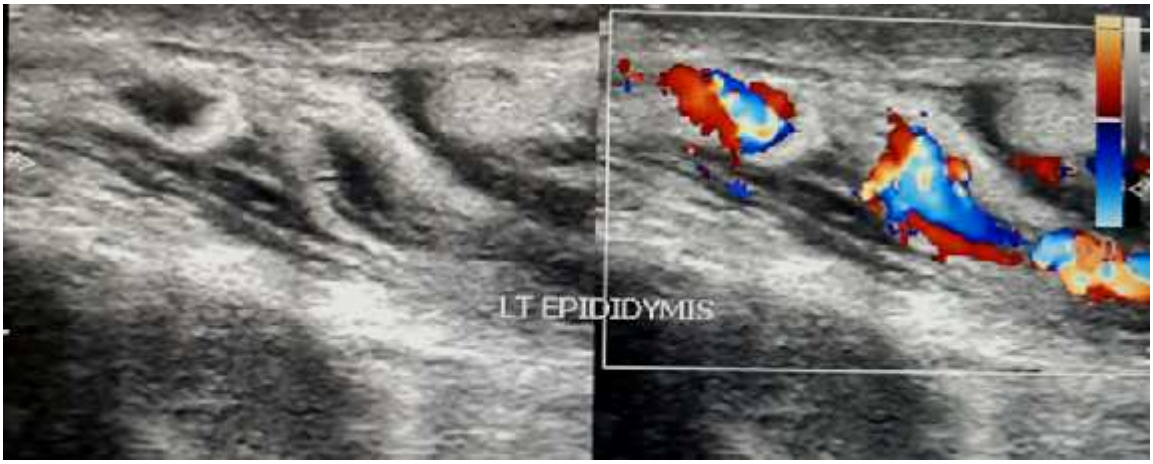


Figure no.51 & 52

On gray scale imaging, bulky epididymis.

On color Doppler imaging, increased vascularity is seen.

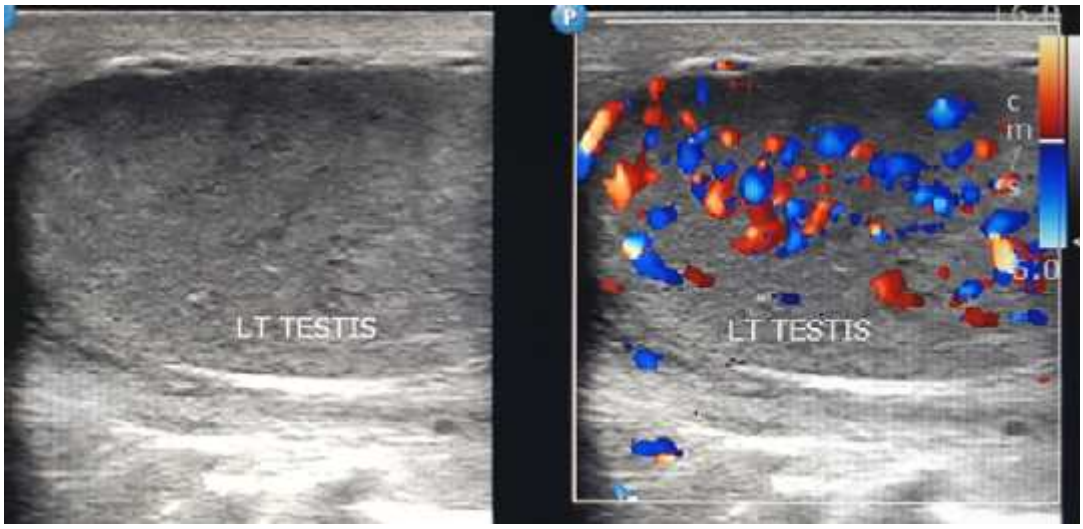


Figure no. 53

On gray scale imaging, heterogeneous echotexture of testis.

On color Doppler imaging, increased vascularity of testis.

To conclude: Bulky hypervascular epididymis & heterogeneous hypervascular testis.

Diagnosis of epididymo-orchitis.

Case 8 Incarcerated Inguinoscrotal hernia

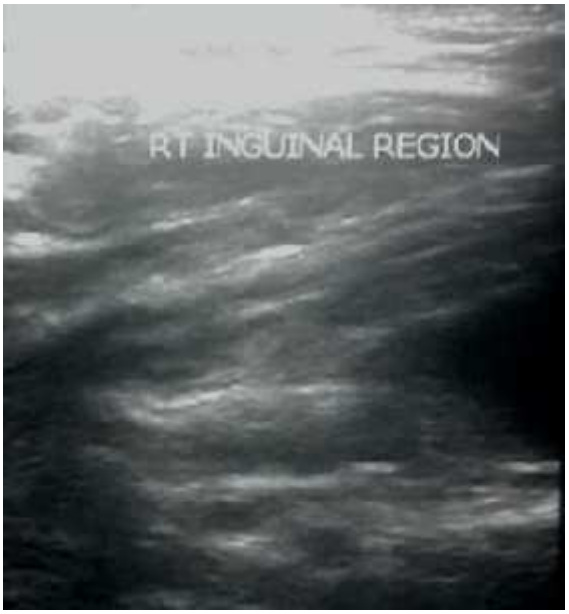


Figure no.54 Incarcerated hernia

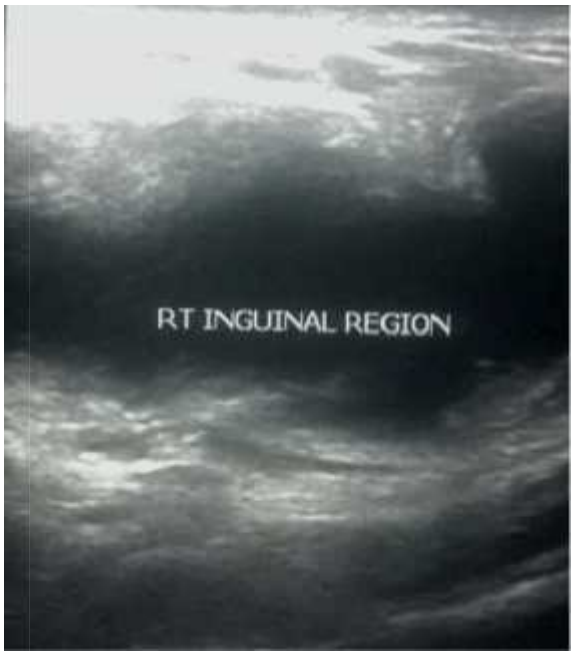


Figure no.55 Incarcerated hernia

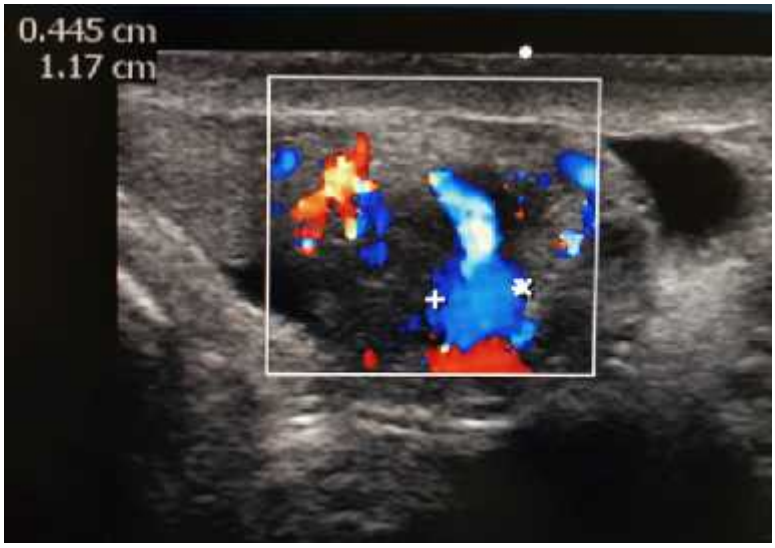
Figure no.56 Incarcerated hernia

All these figures show a continuous dilated fluid filled structure which originated in inguinal canal & continued into scrotum.
On dynamic scanning, no significant peristalsis appreciated.
Diagnosis of incarcerated hernia.

Figure no.57 Incarcerated hernia

Again, no significant peristalsis indicated towards incarcerated hernia.

Case 9 Varicocele



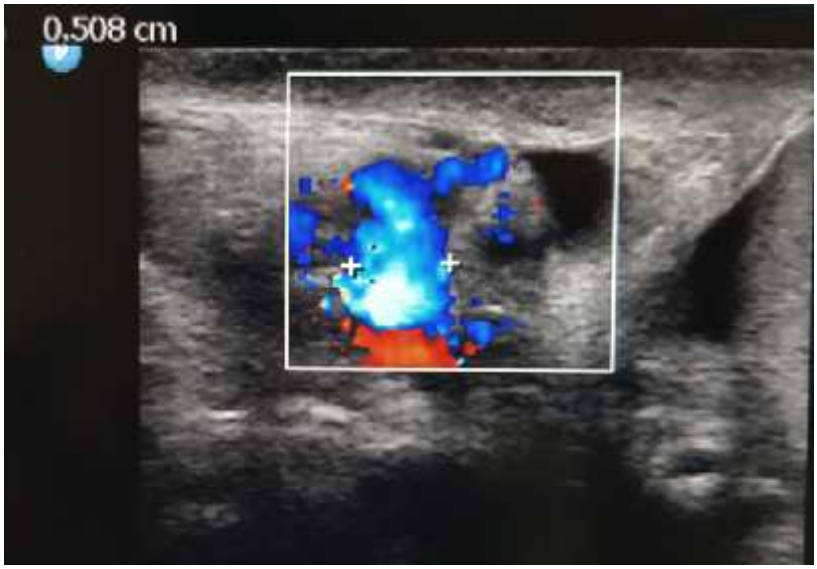
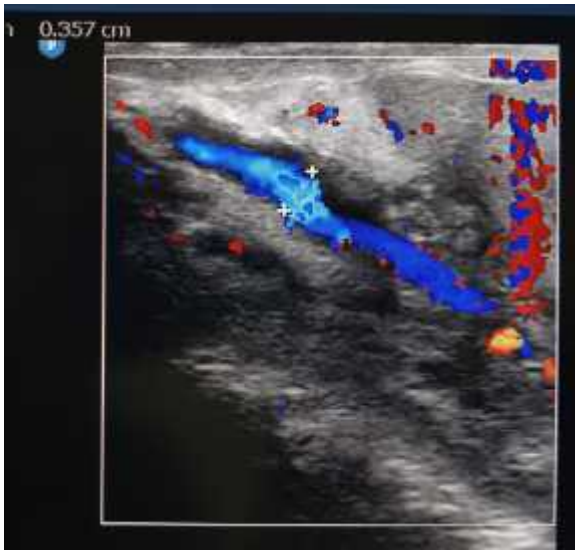


Figure no.58 & 59 Varicocele

On color Doppler imaging, increased size of pampiniform plexus.

Diagnosis of Varicocele.

Case 10 Varicocele



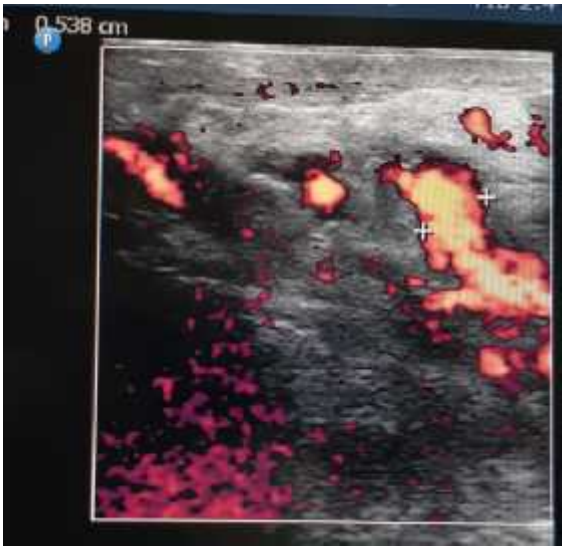


Figure no. 60 & 61 Varicocele

On color Doppler imaging, dilated pampiniform plexus.

Varicocele was the diagnosis.

DISCUSSION

A study involving fifty patients of acute scrotumwas done.The presenting symptoms were pain, erythema & scrotum. The scrotal pain was the most frequent symptom present in the 50 patients. The swelling was present in 18 patients while erythema was noted in 14 patients.

The group of patients ranged from 2 years to 80 years with a mean of 33.8. The most number of cases were 17 in the age group of 21 to 30 years. The least number of cases were found in the age group of 1 to 10 years. Only four cases were present in this age group. There were 4 patients in whom the affected testis size was less than 30 mm. All such patients were less than 10 years of age in our study. There were 26 cases in the size range of 50 to 60 mm.

Apart from age & testicular size, other parameters were testicular echotexture, testicular vascularity, epididymal echotexture & vascularity. Echotexture of affected testis was homogenous in 66% cases, heterogeneous in 24% and predominantly hypoechoic heterogeneous echotexture in 10% cases. Vascularity of testis was increased in 64%, normal in 26% & nil in 10% cases. Epididymis echotexture was heterogeneous in 68% while homogenous in 32% cases. Increased vascularity of epididymis was found in 72% cases while normal in 8% cases. In 10% cases prominent venous channels was a finding which was considered a separate entity in our study. In 10% cases variable vascularity of epididymis was noted due to whirlpool sign.

Torsion

In our study of 50 patients, 5 cases (10%) were diagnosed positive for torsion. There were 2 cases in age group of 11 to 20 years. One case was found in each age group of 1 to 10 years, 21 to 30 years & 50 to 80 years. No patient was found in age group of 41 to 50 years. Pain was present in all the 5 cases. Swelling was present in 4 cases while only one case had erythema. There was no significant difference in size of the affected testis & contralateral normal testis in our study.

The echotexture was hypoechoic heterogeneous in 4 cases out of 5 while one case showed heterogeneous echotexture as compared to opposite side. There was absent vascularity in affected testis in all the cases. In all the five cases there was heterogeneous echogenicity of the epididymis.

Also, whirlpool sign was noted in all the cases, in which there was snail shaped or whorled appearance of spermatic cord affecting the epididymis as well. The part proximal to this whorled appearance was showing vascularity, while distal to it there was absence of vascularity. This was the typical feature present in our study & also the most characteristic one as well. On surgical confirmation, all the five cases were found out to be torsion.

In a study by Vijayaraghavan, whirlpool sign with no vascularity in distal part was present in torsion in the 61 out of 221 cases. This finding was consistent as we found whirlpool sign in all our cases. However in other 4 cases, there was distal vascularity present. Such cases were diagnosed with incomplete torsion. In these 4 cases, there were focal areas of hypoechogenicity with absent vascularity. These were the regions of

segmental infarction in the testis. In our study, there was no such case of partial presence of vascularity in the testis or in the distal part of spermatic cord. The reason may be lower sample size of 50 cases in our study.[48] Cassar et al described that for arterial flow to disappear, minimum of 540° twisting is required. If twisting or rotation is less than 360°, there may be presence of arterial flow with obstruction of venous flow.[70] A snail shaped mass was described by Kalfa et al. in 199 out of 208 patients of torsion. Furthermore, if linear spermatic cord was present, it indicated other causes of other acute scrotum instead of torsion.[49]

Yagil et al found 18 cases of torsion which showed absent intratesticular vascularity and two cases were of hypovascular testis. [50] S A Rizvi et al. found 4 cases of torsion with similar findings.[51] A M Agrawal found 8 cases out of torsion out of 50 cases with similar findings of absent testicular flow. There was sensitivity and specificity of 100%.This was comparable with our study.[54]

Table no.11 Showing comparison of torsion cases of various studies with our study

Study	Total sample size	Complete torsion cases (absent vascularity)	Incomplete torsion (partial vascularity / hypovascular testis)
Our study	50	5	NIL
Vijayraghavan. (2006)	221	61	4
Kalfa et al. (2007)	711	199	9
Yagil et al (2009)	620	18	2
S A Rizvi et al (2010)	122	4	NIL
A M agrawal (2014)	50	8	NIL

Epididymo-orchitis & epididymitis

In our study of 50 patients, 36 cases (72%) were diagnosed for epididymo-orchitis & epididymitis. Out of these 4 cases were diagnosed for epididymitis only.

The maximum number of 12 cases was found out in patients ranging from 21 to 30 years. Other significant age groups for epididymo-orchitis were 50 to 60 years & 31 to 40 years with respective numbers of 8 & 7.

All the 36 cases presented with pain while swelling was present in 6 cases. There was erythema in 13 patients. There was no significant difference in size of the affected testis & contralateral normal testis in our study. Testis was not significantly enlarged in any case. There was homogenous normal echotexture of testis in 24 cases, & it was the finding in majority. Heterogeneous echogenicity was noted in 11 cases while 1 case showed hypoechoic heterogeneous echotexture. Testicular vascularity was characteristically increased in 32 cases while in remaining 4 cases it was normal. In these 4 cases the diagnosis was of epididymitis was provided.

On contrary to testis echotexture, the epididymal echotexture was heterogeneous in majority 29 cases & homogenous in 7 cases. Increased epididymal vascularity was present in all 36 cases. In our study, one case which was diagnosed for epididymo-orchitis was later on confirmed for varicocele. Rest all the cases were confirmed positive with our diagnosis. So in our study, vascularity of testis & epididymis were the major criteria for the diagnosis of epididymo-orchitis and epididymitis.

Vijayaraghavan opined enlarged testis or epididymis or both and increased vascularity as the main diagnostic feature.[48] D'Andrea et al and Thinyu et al also confirmed the same finding. [53, 61] A M Agrawal quoted increased vascularity to be relevant criteria. Testis echogenicity could be variable while epididymis is usually heterogeneous. [54]

Table no.12 showing comparison of epididymo-orchitis including epididymitis in various studies.

Study	Total sample size	Cases	Important feature
Our study	50	36	Increased vascularity of testis & epididymis
Vijayraghavan (2006)	221	65	Enlarged testis and epididymis Increased vascularity
Thinyu et al (2008),	110	52	Increased vascularity
D'Andrea et al (2013)	164	72	Echogenicity variable Increased vascularity
S A Rizvi et al (2010)	122	46	Enlarged hypoechoic testis Increased vascularity
A M Agrawal (2014)	50	33	Coarse and heterogeneous echotexture of epididymis. Increased vascularity

Incarcerated hernia

In our study of 50 patients, there were 2 cases of incarcerated hernia of age 26 years & 50 years. The feature of pain & swelling were present in both cases. Testicular echotexture & vascularity were normal in both of the cases. Similarly epididymis was homogenous with maintained vascularity in both cases.

The diagnostic feature was a dilated akinetic bowel loop present in the inguino-scrotal region. There were internal echoes & fluid within bowel loop with no significant peristalsis on real time ultrasound. Also, omentum was noted as significantly echogenic area. On color Doppler, no significant vascularity in the wall of bowel loop appreciated.

Similar findings were in the previous studies. Ogata et al diagnosed strangulated hernia in 35 out of 39 patient with akinetic loop which was dilated.[66] Celestino et al. also indicated the same feature of dilated akinetic loop of intestine for strangulated hernia.[63]

A M Agrawal et al found 1 case of obstructive inguino-scrotal hernia. Non peristaltic or akinetic bowel loop in the scrotum was the characteristic feature for strangulation of hernia.[54]

Varicocele

In our study of 50 patients, there were 7 cases of varicocele. There were 3 cases in both age group of 21 to 30 years & 41 to 50 years. One patient was more than 50 years of age. Additionally, there was positive history of infertility in 2 patients. There was no patient in age group of less than 20 years. Pain & swelling were present in 7 & 6 cases respectively. While erythema was not there in any case.

Testicular echotexture & vascularity both were normal in all the 7 cases. Epididymis was homogenous in all the cases, but there were significant prominent vascular channels which demonstrated venous flow. This characteristic feature of venous flow with reflux on valsalva maneuver was the diagnostic feature in our study.

Same feature was found in previous studies. R L Bree et al & E D Kim et al described varicocele as tubular structures with anechoic echotexture on gray scale.[25,68] Yagil et al. found 107 cases of varicocele out of 620 with predominant finding of dilated venous channels. But, only in 20 cases urgency was required. In rest of the cases, no immediate action was required.[50] S A Rizvi et al diagnosed 14 cases out of 122 patients with positive finding of anechoic serpiginous areas multiple in number with increased flow in venous channels on valsalva. [51] D'Andrea et al. described varicocele in 18 out of 125 cases. There were venous channels which appeared anechoic, tubular & tortuous on gray scale sonography. There was increased flow on color Doppler.[53]

It was observed in our study that sometimes it was difficult to appreciate the change in size and the reflux. The reason was lack of patient complying with the instruction or due to lack of coordination between the patient, probe & the timing. To overcome this difficulty, multiple attempts were taken for demonstration of flow and reflux.

Limitation found in the study: The relatively less common causes of acute scrotum like fournier's gangrene, idiopathic scrotal wall edema & neoplasms could not be found in our study. This was probably due to smaller sample size.

CONCLUSION

Acute scrotum is an emergency condition in which early decision is required for patient. Depending upon the causative factor for acute scrotum, the clinicians have to manage the patient. Immediate surgical intervention is required for torsion cases & incarcerated hernias.

In our study of 50 patients presenting with acute scrotum, four causes were present, namely torsion, epididymo-orchitis, incarcerated hernia & varicocele. Epididymo-orchitis was found in 36 cases which is statistically higher in number but in these cases medical management was sufficient and patient did not require immediate surgical intervention. Although torsion was found in 5 cases and incarcerated hernia was present in 2 cases, but these cases required urgent surgical management. So here the role of ultrasound along with color Doppler was important to make a decision for patient management.

In our study, from diagnostic point of view, whirlpool sign with absence of vascularity in distal spermatic cord and testis was the key finding for torsion cases. For epididymo-orchitis, increased vascularity in epididymis & testis were the indicative parameters. For incarcerated hernia, the diagnostic point was akinetic bowel loop in the inguino scrotal region with absent or minimal vascularity of that bowel loop. For varicocele, dilated venous channels with reflux on valsalva maneuver was considered. So to conclude, ultrasound with color Doppler is very useful modality for diagnosing acute scrotum.

SUMMARY

There are many causes of acute scrotum the most common being epididymo-orchitis in which medical management is usually sufficient. Other causes like torsion & incarcerated hernia required urgent surgical intervention. As early as possible, these conditions have to be identified to preserve the testis.

Ultrasound with color Doppler is an excellent modality for diagnosis. Apart from being cheap & readily available, it does not provide radiation hazard to gonads. Also, scrotum is superficial structure, so required information can be achieved easily without compromise in resolution.

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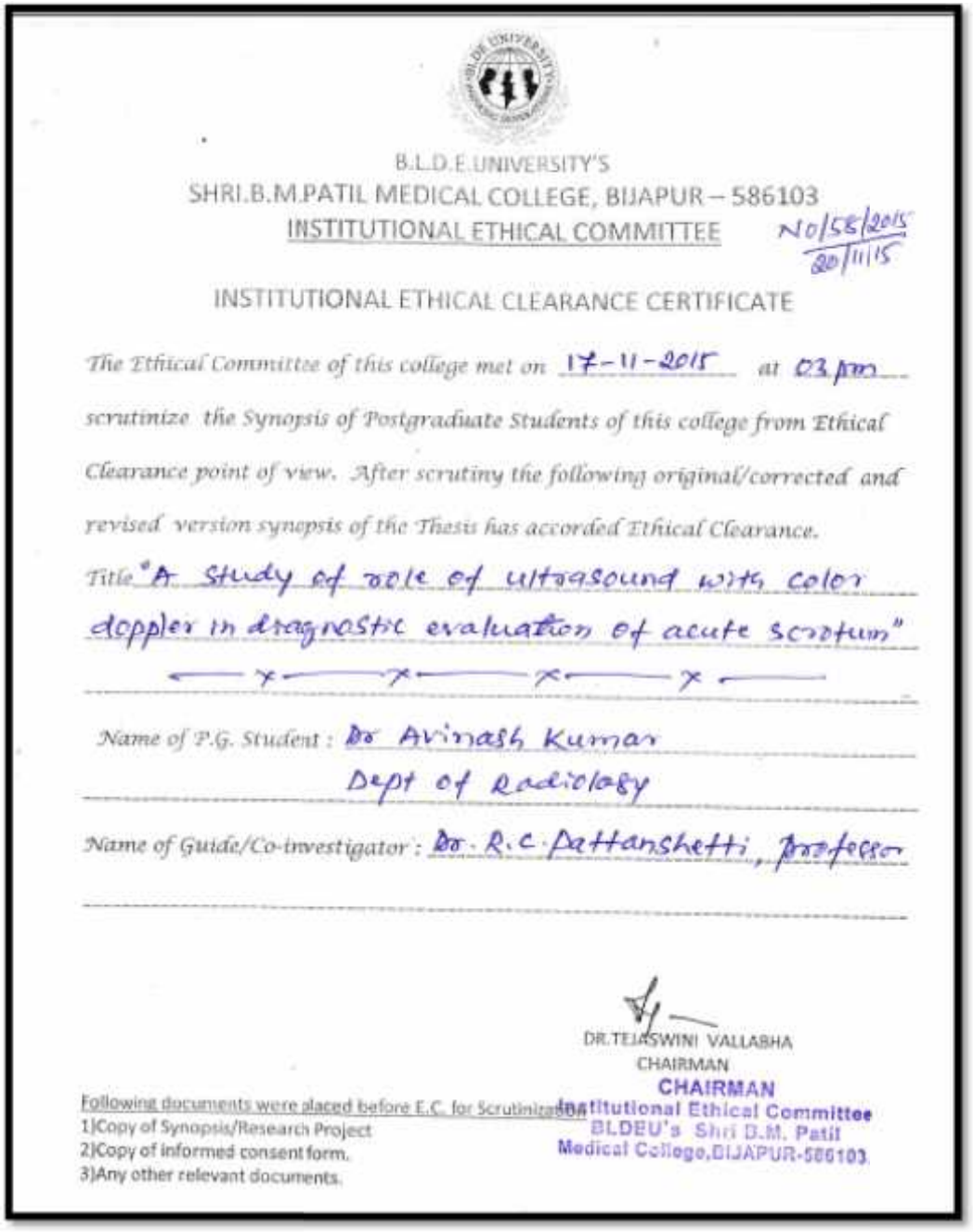
ANNEXURE – I

ETHICAL CLEARENCE



B.L.D.E.UNIVERSITY'S
SHRI.B.M.PATIL MEDICAL COLLEGE, BIJAPUR – 586103
INSTITUTIONAL ETHICAL COMMITTEE No/58/2015 20/11/15

INSTITUTIONAL ETHICAL CLEARANCE CERTIFICATE

The Ethical Committee of this college met on 17-11-2015 at 03 pm scrutinize the Synopsis of Postgraduate Students of this college from Ethical Clearance point of view. After scrutiny the following original/corrected and revised version synopsis of the Thesis has accorded Ethical Clearance.

Title "A Study of role of ultrasound with color doppler in diagnostic evaluation of acute scrotum"

Name of P.G. Student : Dr Avinash Kumar
Dept of Radiology

Name of Guide/Co-investigator : Dr. R.C. Pattanshetti, Professor

DR.TEJASWINI VALLABHA
CHAIRMAN
CHAIRMAN
Institutional Ethical Committee
BLDEU's Shri B.M. Patil
Medical College,BIJAPUR-586103

Following documents were placed before E.C. for Scrutinization
1)Copy of Synopsis/Research Project
2)Copy of informed consent form.
3)Any other relevant documents.

ANNEXURE – II

PROFORMA OF THE STUDY

Name: Age/ sex:

Clinical:

1. History:

2. Clinical diagnosis:

I. Ultrasound

Findings:

Diagnosis:

II. Final diagnosis

By following surgery

Response to therapy

ANNEXURE – III

SAMPLE INFORMED CONSENT FORM

B.L.D.E.U.'s SHRI B.M. PATIL MEDICAL COLLEGE HOSPITAL AND RESEARCH CENTRE, VIJAYPUR – 586103, KARNATAKA

TITLE OF PROJECT: **ROLE OF ULTRASOUND WITH COLOR DOPPLER IN DIAGNOSTIC EVALUATION OF ACUTE SCROTUM**

PRINCIPAL INVESTEGATOR: DR. AVINASH KUMAR

DEPARTMENT OF RADIO DIAGNOSIS

PG GUIDE: DR. R.C. PATTANSHETTI

PROFESSOR

DEPARTMENT OF RADIO-DIAGNOSIS

SHRI B.M. PATIL MEDICAL COLLEGE HOSPITAL & RESEARCH CENTRE, VIJAYPUR - 586103

PURPOSE OF RESEARCH:

I have been informed that the purpose of this study is to assess the role of ultrasound with color Doppler in diagnostic evaluation of acute scrotum**"**

PROCEDURE:

I understand that I will undergo history & clinical examination, ultrasound with color Doppler examination and medical/surgical follow up.

RISKS AND DISCOMFORTS:

I understand that there is no significant risk involved and I may experience mild pain during the above mentioned procedures.

BENEFITS:

I understand that my participation in this study will help to assess role of ultrasound with color Doppler in diagnostic evaluation of acute scrotum

CONFIDENTIALITY:

I understand that the medical information produced by the study will become a part of hospital record and will be subjected to confidentiality and privacy regulations of hospital. If the data is used for publications the identity of the patient will not be revealed.

REQUEST FOR MORE INFORMATION:

I understand that I may ask for more information about the study at any time.

REFUSAL OR WITHDRAWAL OF PARTICIPATION:

I understand that my participation is voluntary and I may refuse to participate or withdraw from study at any time

INJURY STATEMENT:

I understand in the unlikely event of injury to me during the study I will get medical treatment but no further compensations. I will not hold the hospital and its staff responsible for any untoward incidence during the course of study.

I have read the foregoing information, or it has been explained to me in my own language. I have had the opportunity to ask questions about it and any questions that I have asked have been answered to my satisfaction. I consent voluntarily to participate as a participant in this research.

Name of Participant_____ _____

Signature of Participant/Thumb print of participant

KEY TO MASTERCHART

P- PRESENT

A- ABSENT

HM- HOMOGENOUS

HT-HETEROGENEOUS

HP-HYPOECHOIC

IN – INCREASED

NR- NORMAL

NIL- NONE

WP-WHIRLPOOL SIGN

PV-PROMINENT VENOUS CHANNELS

TR- TORSION

EO- EPIDIDYMO-ORCHITIS

ED-EPIDIDYMITIS

ICH- INCARCERATED HERNIA

VC- VARICOCELE