

Chapter one

1.1 Introduction

Testicular ultrasonography is a useful noninvasive tool in both adult and pediatric patient groups. It serves as a good screening and diagnostic tool and helps dictate further management in the appropriate clinical setting. Testicular ultrasonography has a wide range of applications, varying from acute scrotal pain to more chronic and nonspecific symptoms (Cokkinos et al. , 2013).

Scrotal ultrasound (US) is a readily available imaging modality that demonstrates detailed scrotal anatomy without the associated risk of ionizing radiation, with relatively low cost, easy portability, and a lack of need for sedation. Thus, US is an ideal imaging modality for the pediatric scrotum. There is a need, however, for the radiologist to be familiar with the normal findings in children, the appropriate technique, and the US findings of pediatric scrotal pathologies. Many scrotal pathologies have similar clinical presentations and physical examination of the scrotum can be limited by pain or hydrocele. Thus, US examination combined with color Doppler interrogation can add important information for the guidance of treatment. In cases of acute scrotal pain, US can reliably differentiate between testicular torsion and other pathologies(Vijayaraghavan,2006).

Scrotal US can differentiate between solid and cystic masses and localize the mass as either testicular or paratesticular.6 US can also help to evaluate other pathologies including hydrocele, varicocele, and cryptorchidism.(Pearl and Hill 2007).

The testes size, shape, and echotexture depend on testosterone and change from newborns to adolescents(Siegel and Coley,2002).

In infancy, there is an increase in testosterone with a peak around 3-4 months that causes testicular volume to rise to a maximum of 0.44 (± 0.03) cm. After the age of 5 months, the testicular volume steadily declines and reaches its minimum around 9 months of age and then remains approximately the same size until puberty (Kuijper, et al, 2008).

Imaging modalities such as scintigraphy and magnetic resonance imaging (MRI) of the scrotum, which can be applied when ultrasonography proves inadequate, could provide a more accurate diagnosis in the evaluation of testicular perfusion than color Doppler US (Watanabe et al., 2000).

In particular MRI offers useful, and in some cases decisive, information, as it is capable of revealing unexpected findings and elucidating complex aspects. Additionally, MRI helps improve patient management, with an overall reduction in costs. Unfortunately, being specialized, relatively expensive and not always available it is not routinely used for the evaluation of acute painful scrotum but remains an ideal choice for second-line investigation. From the view point that US is more convenient and easier to be performed in the emergency clinical settings than MRI, a contrast-enhanced ultrasound study would be the ideal tool in the assessment of testicular perfusion in patients with acute scrotal symptoms. The acute scrotum is a medical emergency defined as scrotal pain, swelling, and redness of acute onset (Günther and Rübber, 2012).

The differential diagnosis includes torsion, infection, trauma, tumor, and other rarer causes. The diagnostic evaluation begins with history-taking. Scrotal abnormalities can be divided into three groups, which are extra-testicular lesion, intra-testicular lesion and trauma. Causes of scrotal pain include inflammation (epididymitis, epididymo-orchitis, abscess), testicular torsion, testicular trauma, and testicular cancer (Thinyu and Muttarak, 2009).

1.2 The problem

Acute scrotal swelling is a potential emergency. There are many conditions which may present with scrotal swelling including spermatic cord torsion, torsion of testicular appendages, epididymitis, orchitis, scrotal hernia, hydrocele, varicocele, trauma, tumor and testicular pain in vasculitis syndromes such as Schoenlein-Henochpurpura. Testicular torsion is the most important condition that must be proven or ruled out to avoid loss of testicular function. History, physical examination and color-coded doppler-sonography are the tools to diagnose torsion. Using these tools, three diagnostic categories will be defined: Torsion, non-torsion or equivocal diagnosis. In every doubtful case scrotal evaluation is done surgically. Non-torsion is treated according to the different diseases.

1.3 Study objectives:

1.3.1 Main Objective

The main objective of this study was to study acute scrotal diseases by using ultrasound in order determine the sonographic features of the common scrotal lesions.

1.3.2 Specific objectives:

- To account the scrotum lesions and their location.
- to determine the gray scale and color Doppler sonographic features of the common scrotal lesions.
- To diagnose causes of testicular pain or swelling such as inflammation or torsion.

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1.4 Overview of the study:

This study consisted of five chapters

Chapter one:

Is an introduction which include the introduction of the study, the problem, study objectives, and overview of the study.

Chapter two:

background of the study which include anatomy and pathology ,while include previous studies .

Chapter three:

deal with the material & methods used in this study.

Chapter four:

Included result presentation.

Chapter five:

Deal with Discussion ,conclusion and Recommendation.

Chapter two

Background and literature review

2.1 Introduction

Although the development of new imaging modality such as computerized tomography and magnetic resonance imaging have open a new era for medical imaging, high resolution sonography remains as the initial imaging modality of choice for evaluation of scrotal disease. Many of the disease processes, such as testicular torsion, epididymo-orchitis, and intratesticular tumor, produce the common symptom of pain at presentation, and differentiation of these conditions and disorders is important for determining the appropriate treatment. High resolution ultrasound helps in better characterize some of the intrascrotal lesions, and suggest a more specific diagnosis, resulting in more appropriate treatments and avoiding unnecessary operation for some of the diseases.

2.2 Anatomy

The normal adult testis is an ovoid structure measuring 3 cm in anterior-posterior dimension, 2–4 cm in width, and 3–5 cm in length. The weight of each testis normally ranges from 12.5 to 19 g. Both the sizes and weights of the testes normally decrease with age. At ultrasound, the normal testis has a homogeneous, medium-level, granular echotexture. The testicle is surrounded by a dense white fibrous capsule, the tunica albuginea, which is often not visualized in the absence of intrascrotal fluid. However, the tunica is often seen as anechogenic structure where it invaginates into the testis to form the mediastinum testis [Fig.2.1]. In the testis, the seminiferous tubules converge to form the rete testes, which is located in the

mediastinum testis. The rete testis connects to the epididymal head via the efferent ductules. The epididymis is located posterolateral to the testis and measures 6–7 cm in length. At sonography, the epididymis is normally iso- or slightly hyperechoic to the normal testis and its echo texture may be coarser. The head is the largest and most easily identified portion of the epididymis.

It is located superior-lateral to the upper pole of the testicle and is often seen on paramedian views of the testis [Fig. 2. 2]. The normal epididymal body and tail are smaller and more variable in position.



Fig. 2.1 Sonography of a normal testis. The normal testis presents as a structure having homogeneous, medium level, granular echotexture.

The mediastinum testis appears as the hyperechoic region located at the periphery of the testis as seen in this figure. The testis obtains its blood supply from the deferential, cremasteric and testicular arteries.

The right and left testicular arteries, branches of the abdominal aorta, arise just distal to the renal arteries, provide the primary vascular supply to the testes. They course through the inguinal canal with the spermatic cord to the posterior superior aspect of the testis. Upon reaching the testis, the testicular artery divides into branches, which penetrate the tunica albuginea and arborize over the surface of the testis in a layer known as tunica vasculosa.

Centripetal branches arising from the capsular arteries carry blood toward the mediastinum, where they divide to form the recurrent rami that carry blood away from the mediastinum into the testis. The deferential artery, a branch of the superior vesicle artery and the cremasteric artery, a branch of the inferior epigastric artery, supply the epididymis, vas deferens, and peritesticular tissue.

Four testicular appendages have been described: the appendix testis, the appendix epididymis, the vas aberrans, and the paradidymis. They are all remnants of embryonic ducts (Dogra et al 2003, as cited in Cook and Dewbury, 2000). Among them, the appendix testis and the appendix epididymis are usually seen at scrotal US. The appendix testis is a müllerian duct remnant and consists of fibrous tissue and blood vessels within an envelope of columnar epithelium. The appendix testis is attached to the upper pole of the testis and found in the groove between the testis and the epididymis. The appendix epididymis is attached to the head of the epididymis. The spermatic cord, which begins at the deep inguinal ring and descends vertically into the scrotum, consists of vas deferens, testicular artery, cremasteric artery, deferential artery, pampiniform plexuses, genitofemoral nerve, and lymphatic vessel.

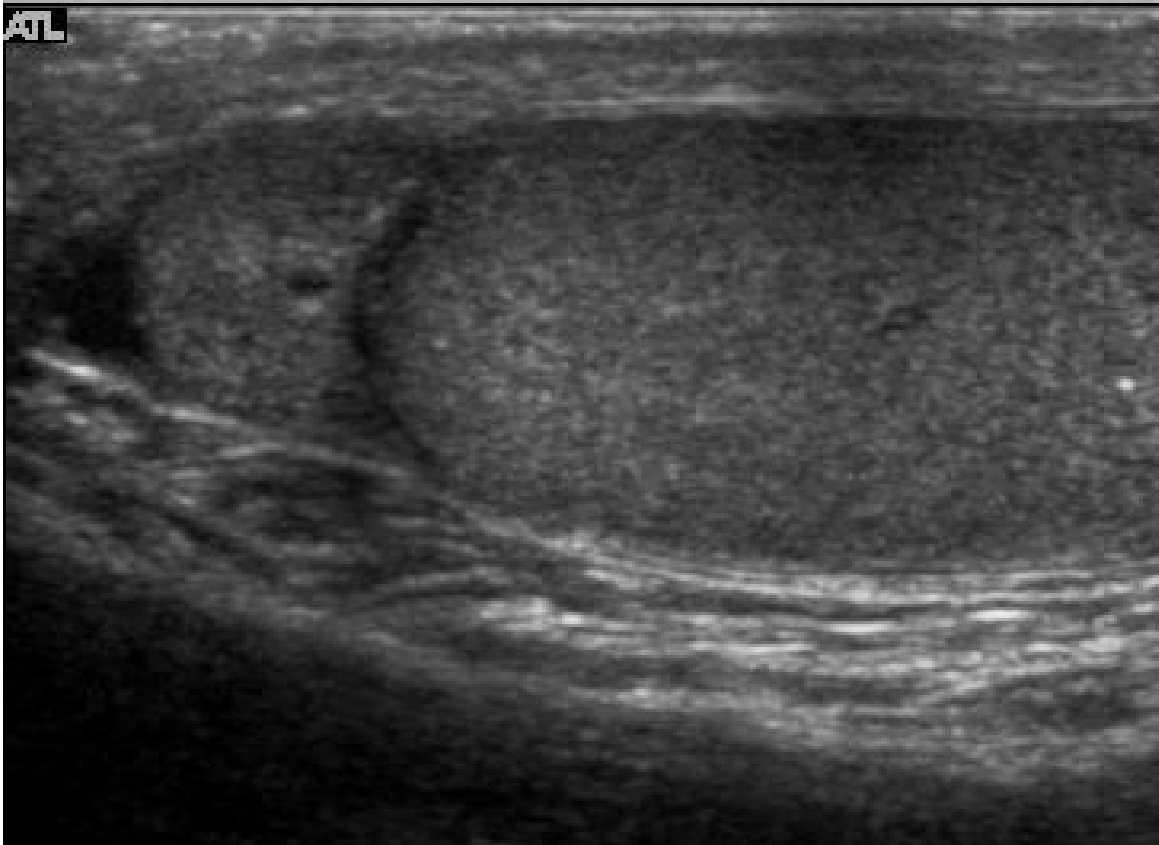


Fig. 2.2 Normal epididymal head. The epididymal head, usually iso- or slightly hyperechoic than the testis is seen located cephalad to the testis

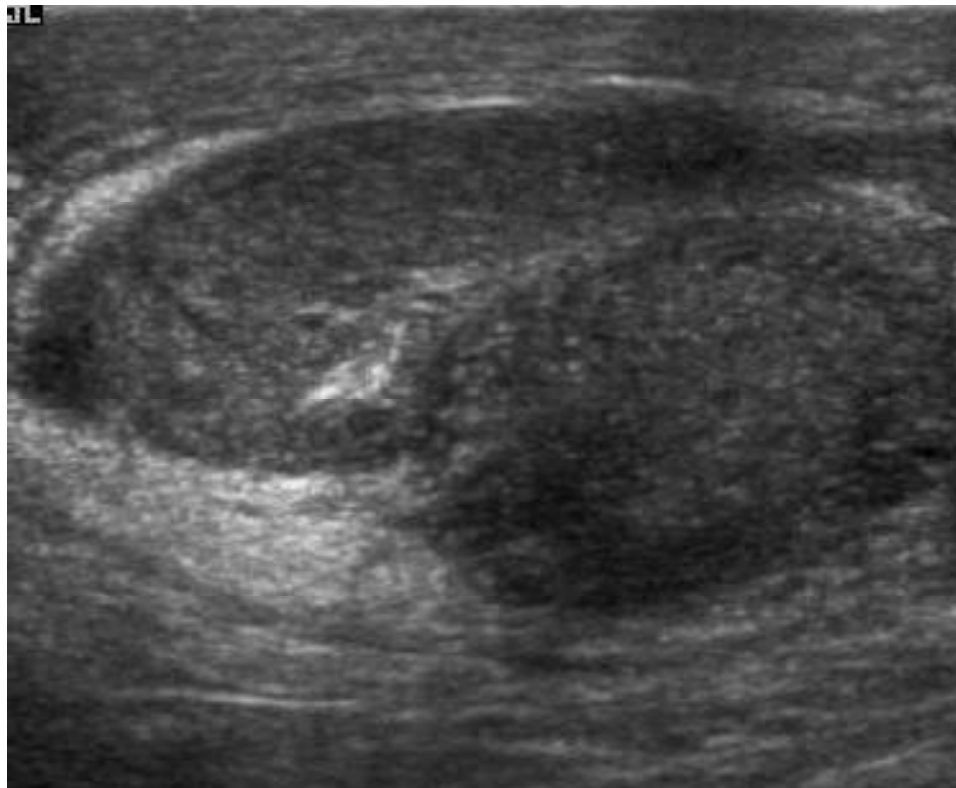
2.3 Pathology

2.3.1 Epididymitis and epididymo-orchitis

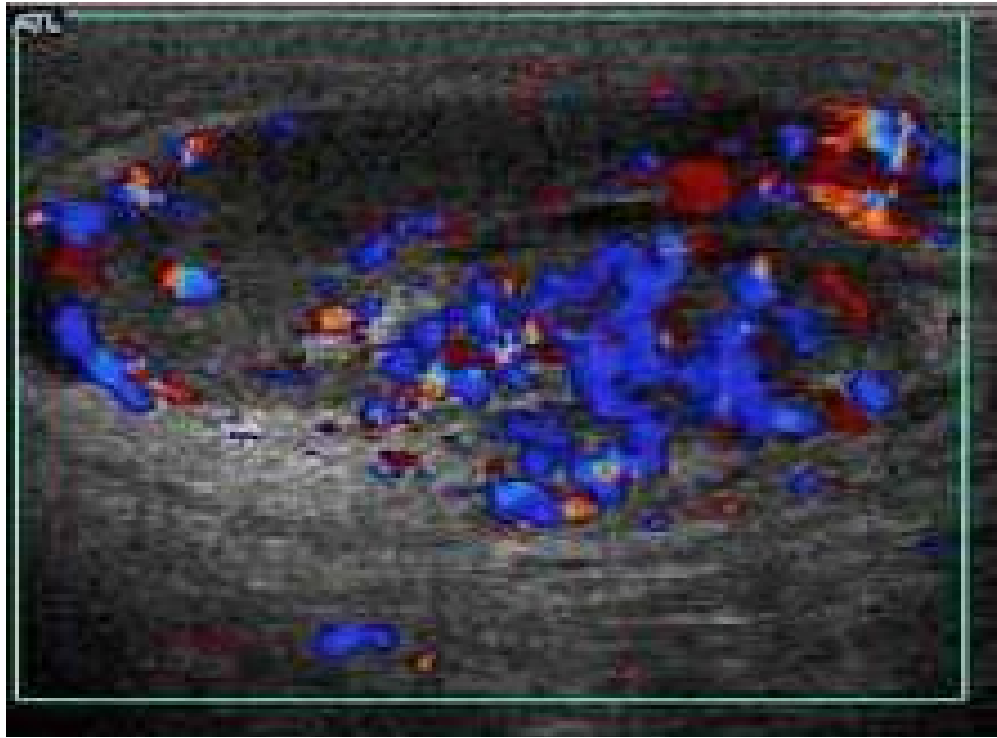
Epididymitis and epididymo-orchitis are common causes of acute scrotal pain in adolescent boys and adults. At physical examination, they usually are palpable as tender and enlarged structures. Clinically, this disease can be differentiated from torsion of the spermatic cord by elevation of the testes above the pubic symphysis. If scrotal pain decreases, it is more likely to be due to epididymitis rather than torsion (Prehn's sign). Most cases of epididymitis are secondary to sexually transmitted disease or retrograde bacteria infection from the urinary bladder.

The infection usually begins in the epididymal tail and spreads to the epididymal body and head. Approximately 20% to 40 % of cases are associated with orchitis due to direct spread of infection into the testis (Kim et al, 2007, as cited in Horstman et al, 1991).

At ultrasound, the findings of acute epididymitis include an enlarged hypoechoic or hyperechoic (presumably secondary to hemorrhage) epididymis [Fig.2.3 a]. Other signs of inflammation such as increased vascularity, reactive hydrocele, pyocele and scrotal wall thickening may also be present. Testicular involvement is confirmed by the presence of testicular enlargement and an inhomogeneous echotexture. Hypervascularity on color Doppler images [Fig.2.3 b] is a well-established diagnostic criterion and may be the only imaging finding of epididymo-orchitis in some men (Kim et al, 2007, as cited in Horstman et al, 1991).



(A)



(b)

Fig.2.3 Epididymo-orchitis in a 77 year-old man. (a) Transverse sonography shows enlargement of the epididymis with hypoechogenicity noted over the testis and epididymis associated with scrotal wall thickening.

(b) Color Doppler sonography showed hyperemic change of the testis and epididymis, presenting as an “inferno” vascular flow pattern.

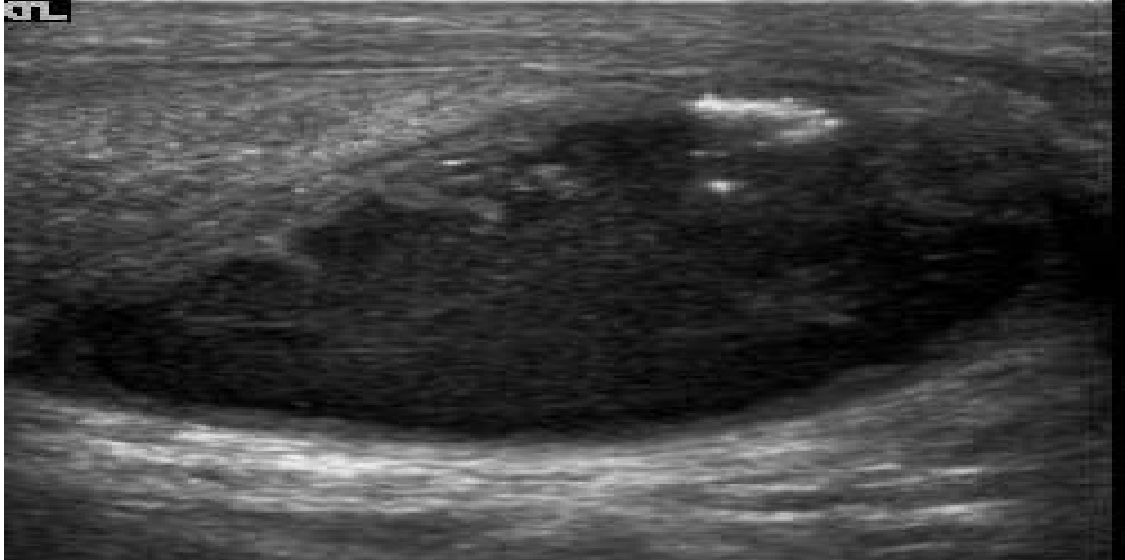
2.3.2 Tuberculous epididymo-orchitis

Although the genitourinary tract is the most common site of extra-pulmonary involvement by tuberculosis, tuberculous infection of the scrotum is rare and occurs in approximately 7% of patients with tuberculosis (Muttarak and Peh, 2006, as cited in Drudi et al, 1997). At the initial stage of infection, the epididymis alone is involved. However if appropriate antituberculous treatment is not administered promptly, the infection will spread to the ipsilateral testis. The occurrence of isolated testicular tuberculosis is rare (Muttarak and Peh, 2006, as cited in Riehle & Jayaraman, 1982). Clinically patients with

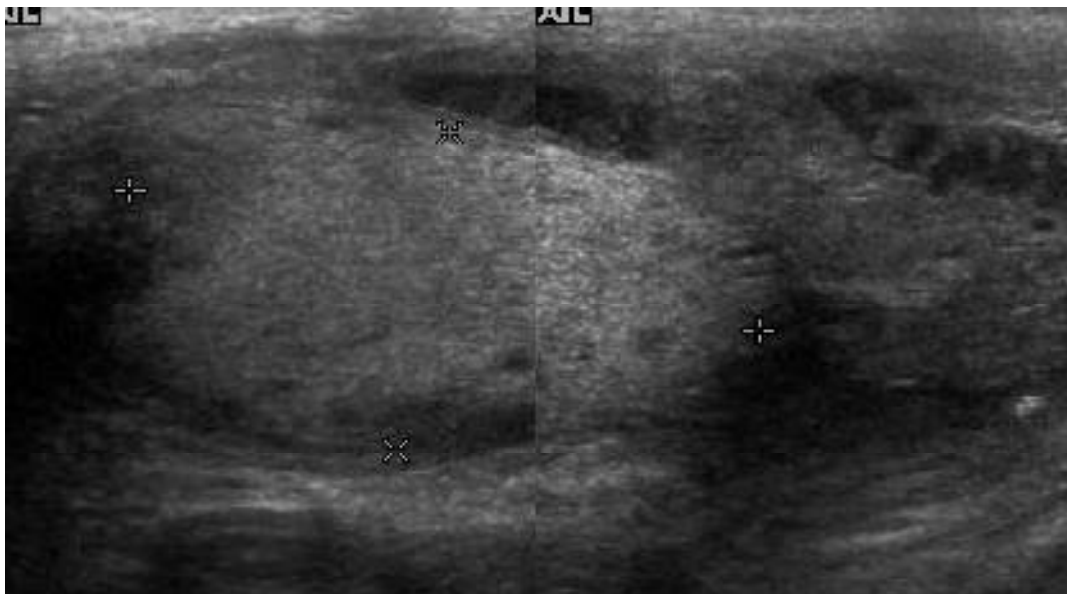
tuberculous epididymo-orchitis may present with painful or painless enlargement of the scrotum, hence they cannot be distinguished from lesions such as testicular tumor, testicular infarction and may mimic testicular torsion. At ultrasound, tuberculous epididymitis is characterized by an enlarged epididymis with variable echogenicity. The presence of calcification, necrosis, granulomas and fibrosis can result in heterogeneous echogenicity [Fig. 2.4a]. The ultrasound findings of tuberculous orchitis are as follow:

- (a) diffusely enlarged heterogeneously hypoechoic testis
- (b) diffusely enlarged homogeneously hypoechoic testis
- (c) nodularly enlarged heterogeneously hypoechoic testis and
- (d) presence of multiple small hypoechoic nodules in an enlarged testis [Fig. 2.4b] (Muttarak and Peh, 2006).

Although both bacterial and tuberculous infections may involve both the epididymis and the testes, an enlarged epididymis with heterogeneously hypoechoic pattern favors a diagnosis of tuberculosis (Muttarak and Peh, 2006, as cited in Kim et al, 1993 and Chung et al, 1997). With color Doppler ultrasound, a diffuse increased blood flow pattern is seen in bacterial epididymitis, whereas focal linear or spotty blood flow signals are seen in the peripheral zone of the affected epididymis in patients with tuberculosis (Muttarak and Peh, 2006, as cited in Yang et al, 2000).



(a)



(b)

Fig.2. 4. Tuberculous epididymo-orchitis. (a) Transverse sonography of a surgically proved tuberculous epididymitis shows an enlarged epididymis containing calcification and necrosis.

(b) Composite image: Transverse sonography of the same patient shows multiple hypoechoic nodules in the left testis associated with surrounding reactive hydrocele

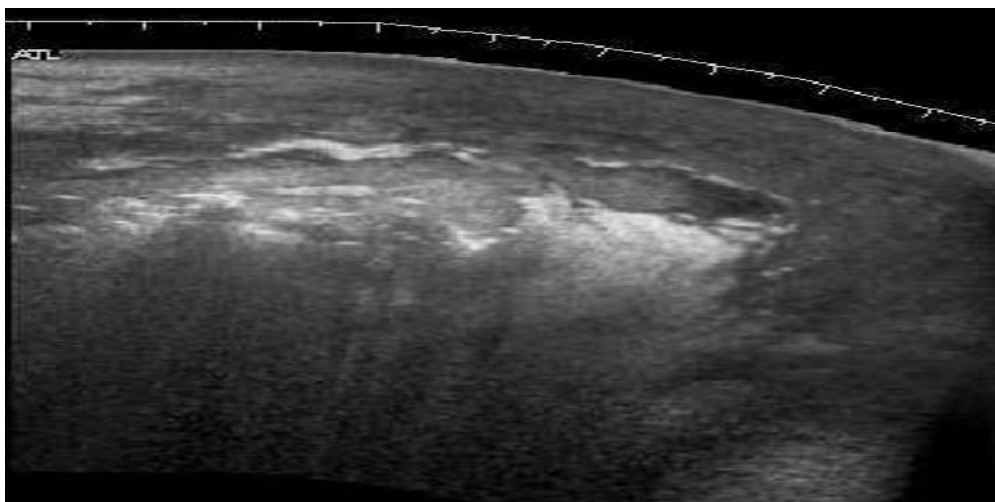
2.3.3 Fournier gangrene

Fournier gangrene is a polymicrobial necrotizing fascitis involving the perineal, perianal, orogenital regions and constitutes a true surgical emergency with a potentially high mortality rate. It usually develops from a perineal or genitourinary infection, but can arise following local trauma with secondary infection of the wound. 40–60% of patients are being diabetic.

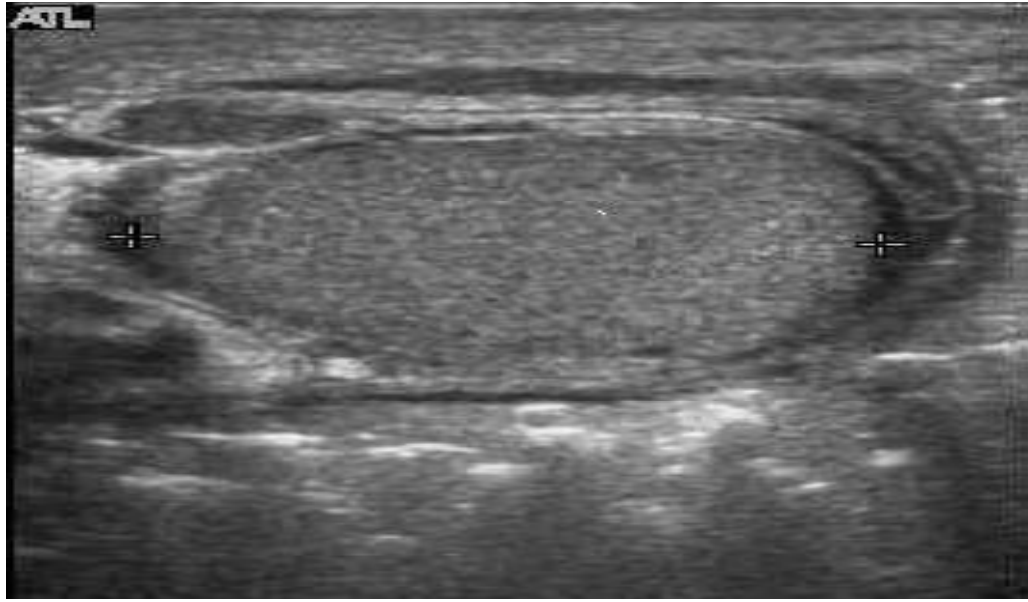
Although the diagnosis of Fournier gangrene is often made clinically, diagnostic imaging is useful in ambiguous cases.

The sonographic hallmark of Fournier gangrene is presence of subcutaneous gas within the thickened scrotal wall. At ultrasound, the gas appears as numerous, discrete, hyperechoic foci with reverberation artifacts [Fig. 2.5]. Evidence of gas within the scrotal wall may be seen prior to clinical crepitus.

The only other condition manifesting with gas at sonographic examination is an inguinoscrotal hernia. This can be differentiated from Fournier gangrene by the presence of gas within the protruding bowel lumen and away from the scrotal wall. (Levenson et al, 2008).



(a)



(b)

Fig.2. 5.Fournier gangrene. (a) Transverse sonography image shows echogenic areas with dirty shadowing representing air in the perineum. (b) Gas presented as numerous, discrete, hyperechoic foci with reverberation artifacts are seen at scrotal wall

2.3.4 Other benign lesions of the scrotum

2.3.5 Tubular ectasia

The normal testis consists of several hundred lobules, with each lobule containing several seminiferous tubules. The seminiferous tubules of each lobule merge to form the straight tubes, which in turn converge to form the rete testis. The rete testis tubules, which lie within the mediastinum testis, are an anastomosing network of irregular channels with a broad lumen, which then empties into the efferent ductules to give rise to the head of the epididymis.

Obstruction in the epididymis or efferent ductules may lead to cystic dilatation of the efferent ductules, which usually presents as an epididymal cyst on ultrasound.

However, in the more proximal portion this could lead to the formation of an intratesticular cyst or dilatation of the tubules, so called tubular ectasia. Factors contributing to the development of tubular ectasia include epididymitis, testicular biopsy, vasectomy or an aging process (Mak et al 2007b). Clinically this lesion is usually asymptomatic. The ultrasound appearance of a microcystic or multiple tubular-like lesions located at the mediastinal testis [Fig.2. 6] and associated with an epididymal cyst in a middle-aged or elderly patient should alert the sonographer to the possibility of tubular ectasia.

The differential diagnosis of a multicystic lesion in testis should include a cystic tumor, especially a cystic teratoma.

A cystic teratoma is usually a palpable lesion containing both solid and cystic components; and the cysts are normally larger than that of tubular ectasia, which appear microcystic [Fig.2. 7]. Furthermore, the location of tubular ectasia in the mediastinum testis is also helpful in making the differential diagnosis.

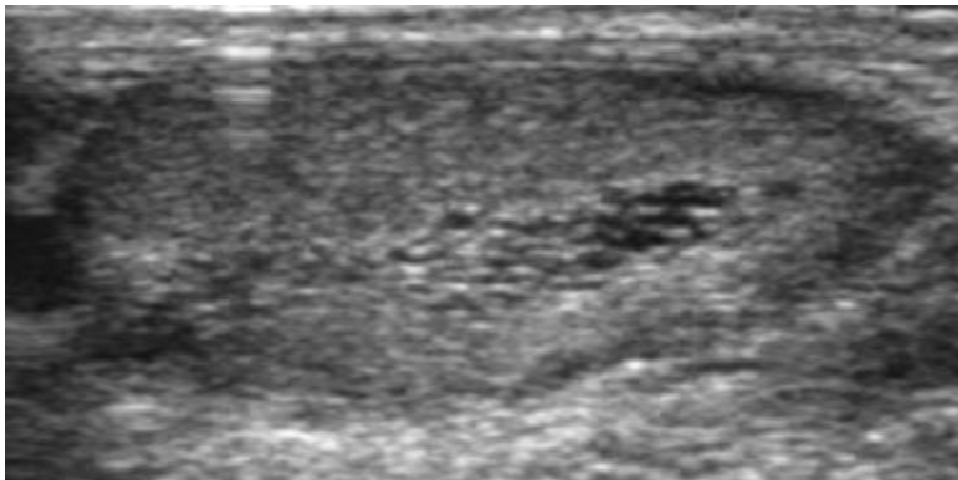


Fig.2.6. Tubular ectasia of the testis. Honey-comb shaped cystic lesion at mediastinum testis

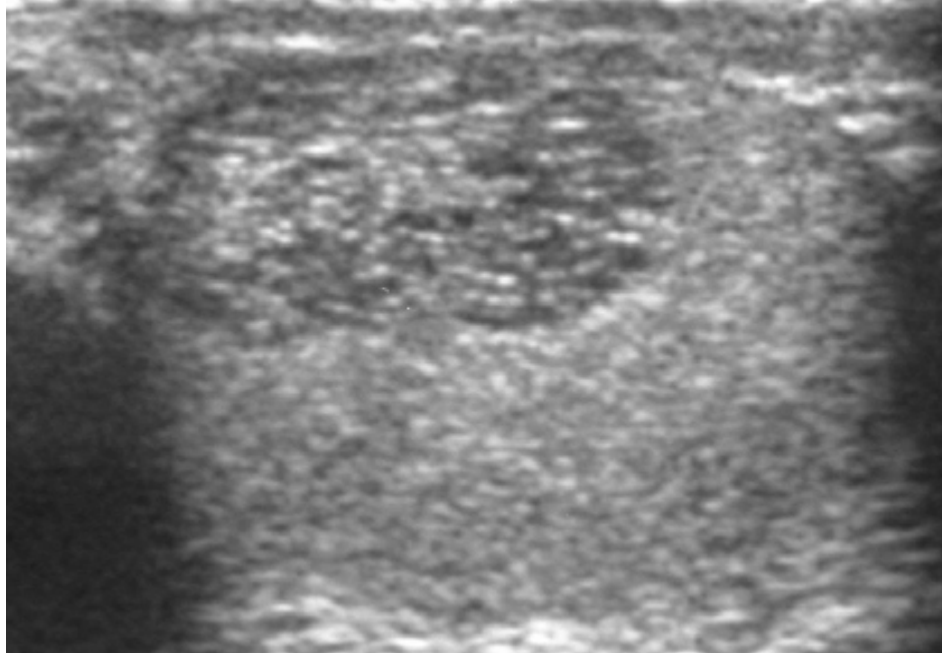


Fig. 2.7. Tubular ectasia of the testis (Reproduced with permission from British Institute of Radiology, British Journal of Radiology 2007; 80: 67-68). Lesion in the testis mimicking testicular tumor, but the microcystic appearance of this lesion is suggestive of tubular ectasia

2.3.6 Testicular microlithiasis

Histologically, testicular microlithiasis refers to the scattered laminated calcium deposits in the lumina of the seminiferous tubules. These calcifications arise from degeneration of the cells lining the seminiferous tubules. At ultrasonography, microliths appear as tiny punctuate echogenic foci, which typically do not shadow. Although minor microcalcification within a testis is considered normal, the typical US appearance of testicular microlithiasis is of multiple nonshadowing echogenic foci measuring 2–3 mm and randomly scattered throughout the testicular parenchyma (Fig. 2. 8) (Dogra et al, 2003, as cited in Janzen et al, 1992).

The clinical significance of testicular microlithiasis is that it is associated with increased risk of testicular malignancy, thus follow up of affected individuals with scrotal sonography is necessary to ensure that a testicular tumor does not develop.

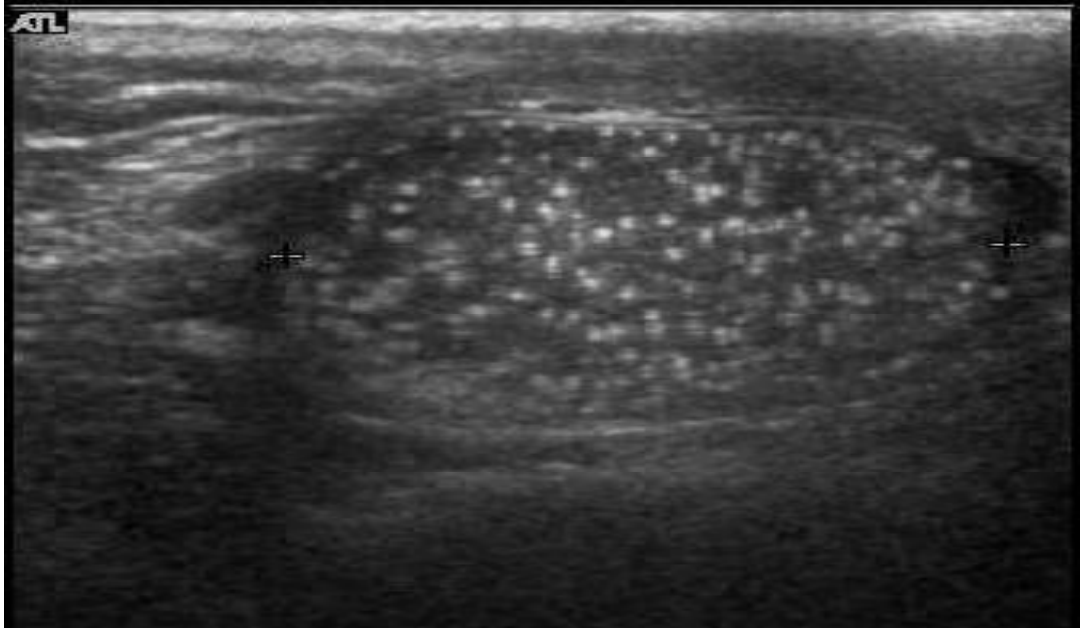


Fig.2.8. Testicular microlithiasis. Multiple hyperechoic foci without acoustic shadow presenting as a starry sky appearance is seen in the testis

2.3.7 Testicular torsion

The normal testis and epididymis are anchored to the scrotal wall. If there is a lack of development of these attachments, the testis is free to twist on its vascular pedicle. This will result in torsion of the spermatic cord and interruption of testicular blood flow. Testicular torsion occurs most commonly at 12 to 18 years but can occur at any age. Torsion results in swelling and edema of the testis, and as the edema increases, testicular perfusion is further altered. The extent of testicular ischemia depends on the degree of torsion, which ranges from 180° to 720° or greater. The testicular salvage rate depends on the degree of torsion and the duration of ischemia. A nearly 100% salvage rate exists within the first 6 hours after the onset of symptoms; a 70% rate, within 6–12 hours; and a 20% rate, within

12–24 hours(Dogra et al, 2003, as cited in Patriquin et al, 1993). Therefore testicular torsion is a surgical emergency and the role of ultrasound is to differentiate it from epididymitis as both disease presents with acute testicular pain clinically.

There are two types of testicular torsion: extravaginal and intravaginal. Extravaginal torsion occurs exclusively in newborns. Ultrasound findings include an enlarged heterogeneous testis, ipsilateral hydrocele, thickened scrotal wall and absence of vascular flow in the testis and spermatic cord (Dogra et al 2003, as cited in Brown et al, 1990). The ultrasound findings of intravaginal torsion vary with the duration and the degree of rotation of the spermatic cord. Gray scale ultrasound may appear normal if the torsion is just occurred. At 4-6 hours after onset of torsion, enlarged testis with decreased echogenicity is seen. At 24 hours after onset, the testis appears heterogeneous due to vascular congestion, hemorrhage and infarction (Dogra et al, 2003). As gray scale ultrasound is often normal during early onset of torsion, Doppler sonography is considered as essential in early diagnosis of testicular torsion. The absence of testicular flow at color and power Doppler ultrasound is considered diagnostic of ischemia [Fig.2. 9], provided that the scanner is set

for detection of slow flow, the sampling box is small and the scanner is adjusted for the lowest repetition frequency and the lowest possible threshold setting.

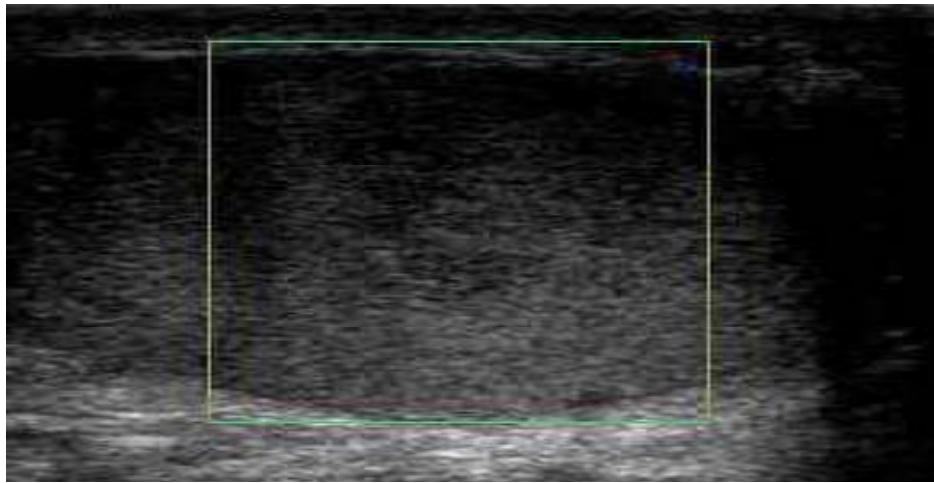
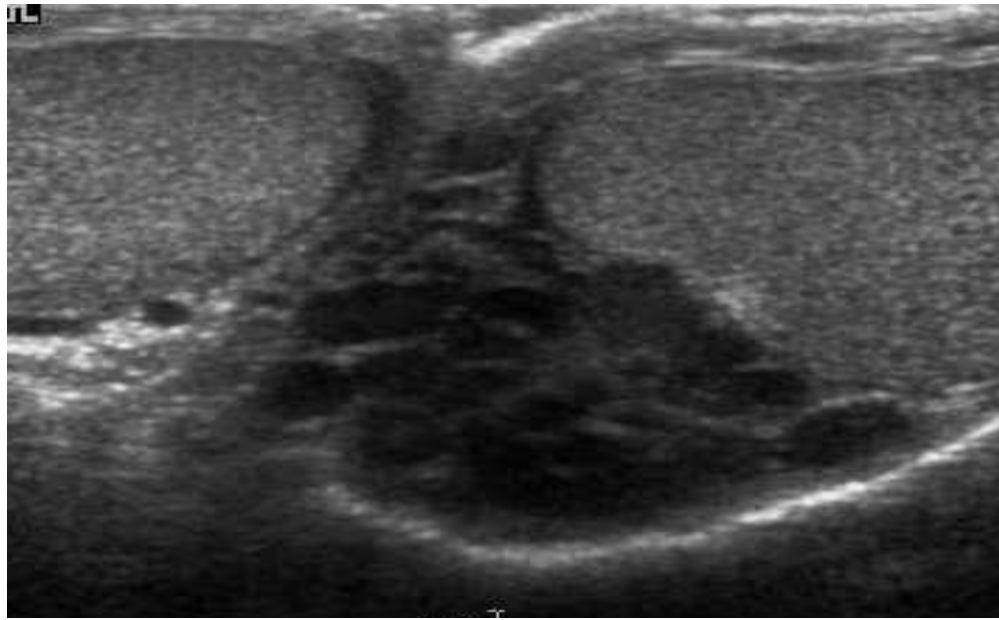


Fig.2.9. Testicular torsion of the right testis. Absence of vascular flow and ill-defined hypoechoic lesions are seen in the testis

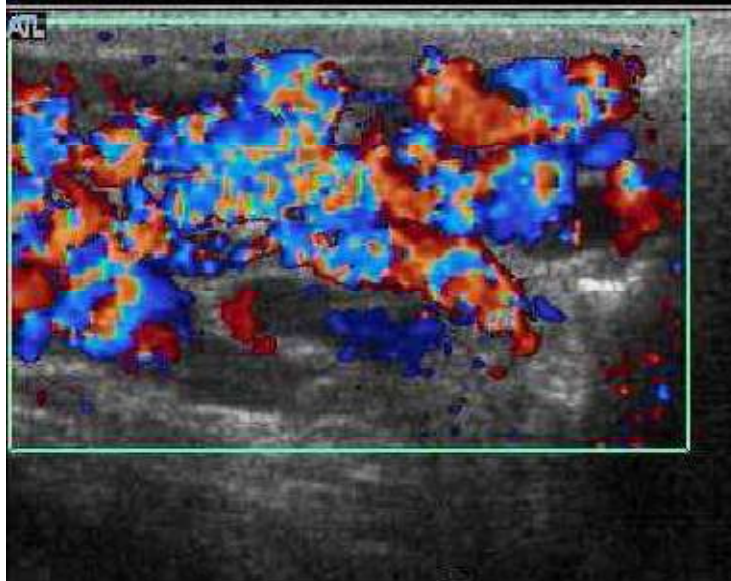
2.3.8 Varicocele

Varicocele refers to an abnormal dilatation of the veins of the spermatic cord due to incompetence of valve in the spermatic vein. This results in impaired blood drainage into the spermatic vein when the patient assumes a standing position or during Valsalva's maneuver. Varicoceles are more common on the left side due to the following reasons (a) The left testicular vein is longer; (b) the left testicular vein enters the left renal vein at a right angle; (c) the left testicular artery in some men arches over the left renal vein, thereby compressing it; and (d) the descending colon distended with feces may compress the left testicular vein (Mehta and, Dogra, 1998). The US appearance of varicocele consists of multiple, hypoechoic, serpiginous, tubular like structures of varying sizes larger than 2 mm in diameter

that are usually best visualized superior or lateral to the testis [Fig. 2.10a]. Color flow and duplex Doppler US optimized for low-flow velocities help confirm the venous flow pattern, with phasic variation and retrograde filling during a Valsalva's maneuver [Fig. 2.10b]. Intratesticular varicocele may appear as a vague hypoechoic area in the testis or mimics tubular ectasia. With color Doppler, this intratesticular hypoechoic area also showed reflux of vascular flow during Valsalva's maneuver [Fig. 2. 11]



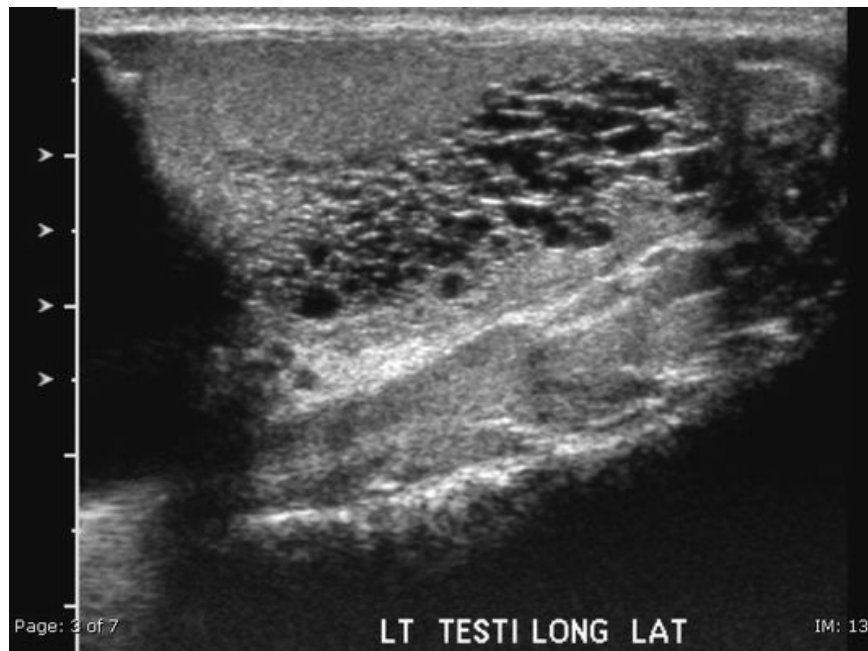
(a)



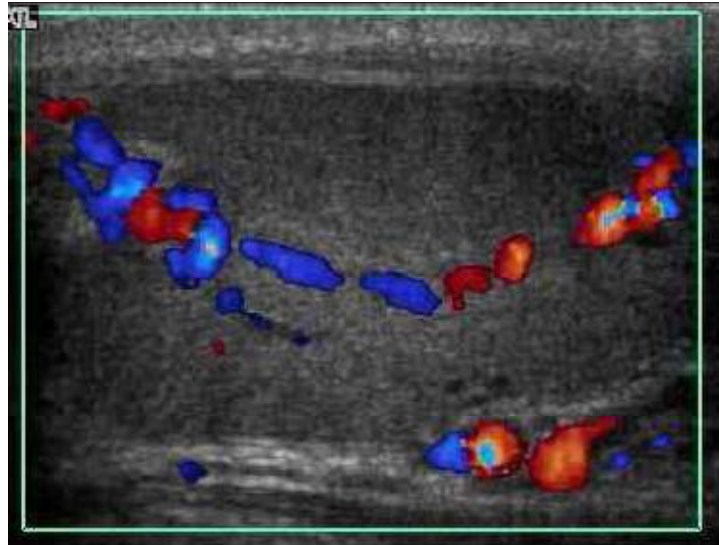
(b)

Fig.2. 10.Varicocele. (a) Multiple tortuous tubular like structure are seen in the left scrotum.

(b) Color Doppler sonography shows vascular reflux during Valsalva's maneuver



(a)



(b)

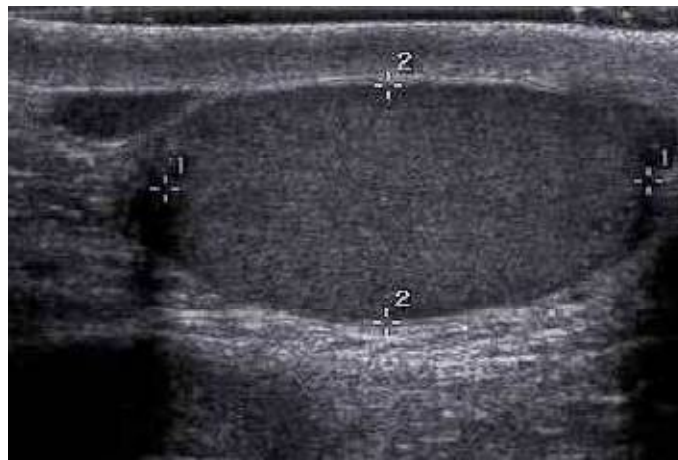
Fig. 2.11 Intratesticular varicocele. (a) Dilated tubular structures are seen within the testis. (b) Presence of vascular reflux is noted during Valsalva's maneuver

2.3.9 Undescended testis (Cryptorchidism)

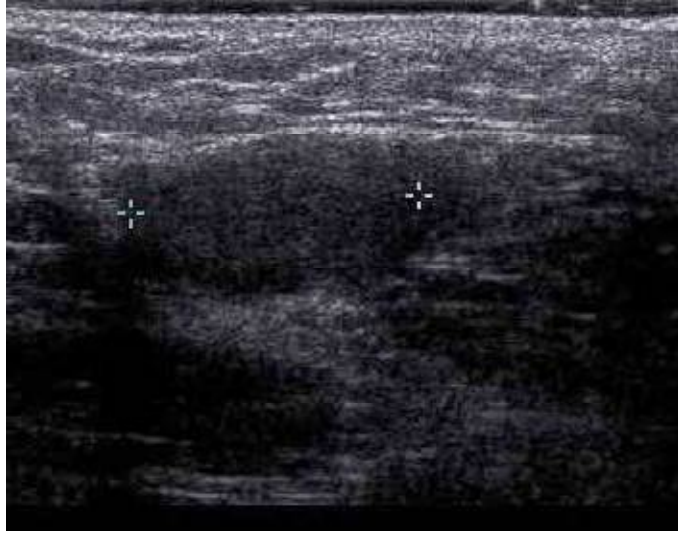
Normally the testes begin its descent through the inguinal canal to the scrotum at 36 weeks of gestation and completed at birth. Failure in the course of testes descent will result in undescended testes. Undescended testis is found in 4% of full-term infants and only 0.8% of males at the age of 1 year have true cryptorchidism. Although an undescended testis can be found anywhere along the pathway of descent from the retroperitoneum to the scrotum, the inguinal canal is the most common site for an undescended testis. Deviation of testis from the normal pathway of descent will result in ectopic testis that is commonly seen in pubopenile, femoral triangle and perineal regions.

Besides infertility, undescended testes carry an increased risk of malignancy even for the normally located contralateral testis. The risk of malignancy is estimated to be as high as 10 times the normal individual with seminoma being the most

common malignancy. The incidence of infertility is decreased if surgical orchiopexy is carried out before the 1-3 years but the risk of malignancy does not change. Because of the superficial location of the inguinal canal in children, sonography of undescended testes should be performed with a high frequency transducer. At ultrasound, the undescended testis usually appears small, less echogenic than the contralateral normal testis and usually located in the inguinal region [Fig. 2.12]. With color Doppler, the vascularity of the undescended testis is poor.



(a)



(b)

Fig. 2.12. Undescended testis. (a) Normal testis in the scrotum. (b) Atrophic and decreased echogenicity of the contralateral testis of the same patient seen in the inguinal region

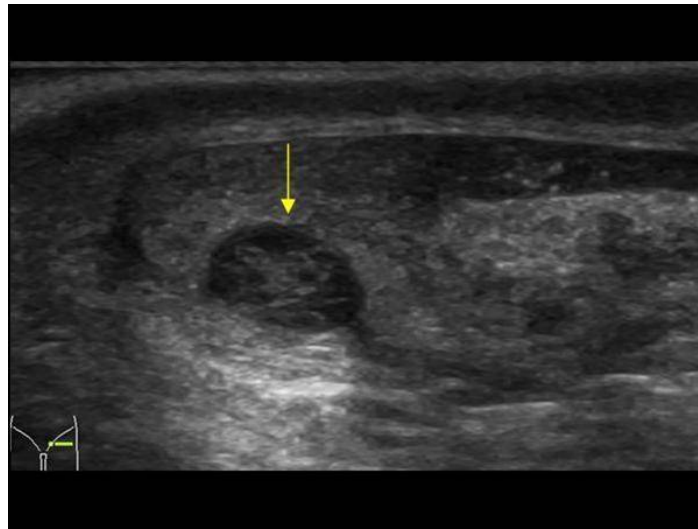


Fig. 2.13. Testicular appendiceal torsion. A hyperechoic lesion with surrounding vascularity is seen in the groove between the testis and epididymis

2.3.10 Testicular appendiceal torsion

At sonography, the appendix testis usually appears as a 5 mm ovoid structure located in the groove between the testis and the epididymis. Normally it is isoechoic to the testis but at times it may be cystic. The appendix epididymis is of the same size as the appendix testis but is more often pedunculated. Clinically pain may occur with torsion of either appendage.

Physical examination showed a small, firm nodule is palpable on the superior aspect of the testis and a bluish discoloration known as “blue dot” sign may be seen on the overlying skin (Dogra and Bhatt 2004, as cited in Skoglund et al 1970). Torsion of the appendiceal testis most frequently involved in boys aged 7-14 years (Dogra and Bhatt 2004).

The sonographic features of testicular appendiceal torsion includes a circular mass with variable echogenicity located adjacent to the testis or epididymis [Fig.2. 13], reactive hydrocele and skin thickening of the scrotum is common, increased peripheral vascular flow may be found around the testicular appendage on color Doppler ultrasound. Surgical intervention is unnecessary and pain usually resolves in 2 to 3 days with an atrophied or calcified appendages remaining.

2.3.11 Intratesticular tumors

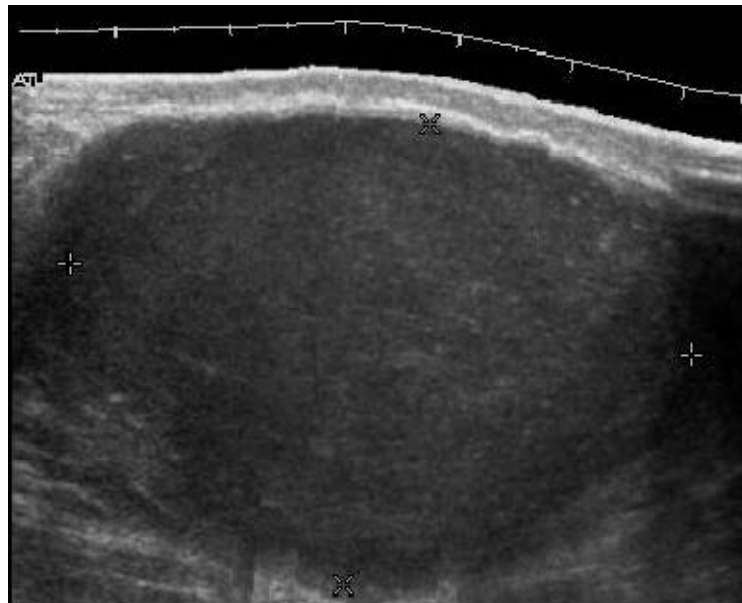
One of the primary indications for scrotal sonography is to evaluate for the presence of intratesticular tumor in the setting of scrotal enlargement or a palpable abnormality at physical examination. It is well known that the presence of a solitary intratesticular solid mass is highly suspicious for malignancy. Conversely, the vast majority of extratesticular lesions are benign.

2.3.12 Germ cell tumors

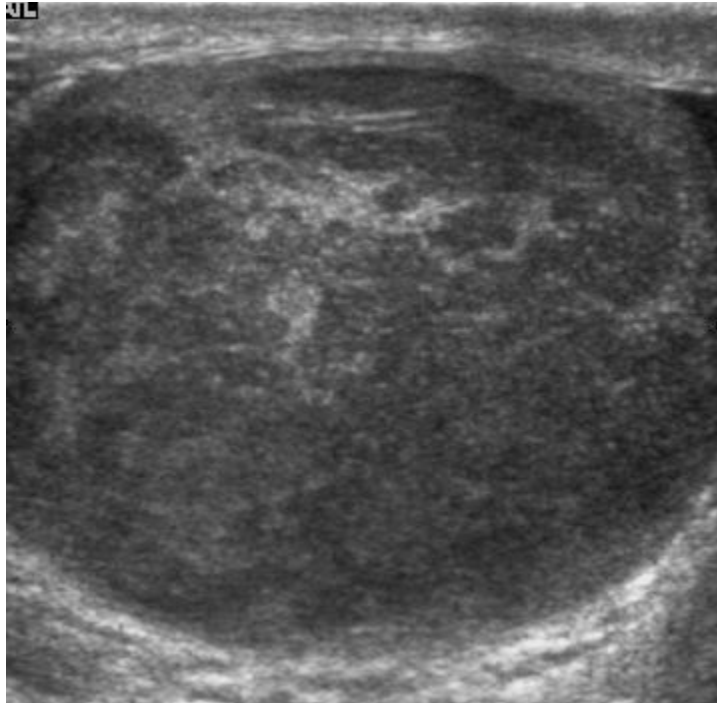
Primary intratesticular malignancy can be divided into germ cell tumors and non-germ cell tumors. Germ cell tumors are further categorized as either seminomas or nonseminomatous tumors. Other malignant testicular tumors include those of gonadal stromal origin, lymphoma, leukemia, and metastases.

2.3.13 Seminoma

Approximately 95% of malignant testicular tumors are germ cell tumors, of which seminoma is the most common. It accounts for 35%–50% of all germ cell tumors (Woodward et al, 2002). Seminomas occur in a slightly older age group when compared with other nonseminomatous tumor, with a peak incidence in the fourth and fifth decades. They are less aggressive than other testicular tumors and usually confined within the tunica albuginea at presentation. Seminomas are associated with the best prognosis of the germ cell tumors because of their high sensitivity to radiation and chemotherapy (Kim et al, 2007).



(a)



(b)

Fig.2.14. Seminoma. (a) Seminoma usually presents as a homogeneous hypoechoic nodule confined within the tunica albuginea. (b) Sonography shows a large heterogeneous mass is seen occupying nearly the whole testis but still confined within the tunica albuginea, it is rare for seminoma to invade to peritesticular structures

Seminoma is the most common tumor type in cryptorchid testes. The risk of developing a seminoma is increased in patients with cryptorchidism, even after orchiopexy. There is an increased incidence of malignancy developing in the contralateral testis too, hence sonography is sometimes used to screen for an occult tumor in the remaining testis.

On US images, seminomas are generally uniformly hypoechoic, larger tumors may be more heterogeneous [Fig.2. 14]. Seminomas are usually confined by the tunica albuginea and rarely extend to peritesticular structures. Lymphatic spread to retroperitoneal lymph nodes and hematogenous metastases to lung, brain, or both are evident in about 25% of patients at the time of presentation (Dogra et al 2003, as cited in Guthrie & Fowler, 1992)

2.3.14 Nonseminomatous germ cell tumors

Nonseminomatous germ cell tumors most often affect men in their third decades of life.

Histologically, the presence of any nonseminomatous cell types in a testicular germ cell tumor classifies it as a nonseminomatous tumor, even if most of the tumor cells belong to seminoma. These subtypes include yolk sac tumor, embryonal cell carcinoma, teratocarcinoma, teratoma, and choriocarcinoma. Clinically nonseminomatous tumors usually present as mixed germ cell tumors with variety cell types and in different proportions.

2.3.15 Embryonal cell carcinoma

Embryonal cell carcinomas, a more aggressive tumor than seminoma usually occurs in men in their 30s. Although it is the second most common testicular tumor after seminoma, pure embryonal cell carcinoma is rare and constitutes only about 3 percent of the nonseminomatous germ cell tumors. Most of the cases occur in combination with other cell types. At ultrasound, embryonal cell carcinomas are predominantly hypoechoic lesions with ill-defined margins and an inhomogeneous echotexture. Echogenic foci due to hemorrhage, calcification, or fibrosis are commonly seen. Twenty percent of embryonal cell carcinomas have cystic components (Dogra et al, 2003). The tumor may invade into the tunica albuginea resulting in contour distortion of the testis [Fig. 2.15].



Fig.2. 15.Embryonal cell carcinoma. Longitudinal ultrasound image of the testis shows an irregular Yolk sac tumors also known as endodermal sinus tumors account for 80% of childhood testicular tumors, with most cases occurring before the age of 2 years(Woodward et al, 2002, as cited in Frush& Sheldon 1998).

Alpha-fetoprotein is normally elevated in greater than 90% of patients with yolk sac tumor (Woodward et al, 2002, as cited in Ulbright et al, 1999). In its pure form, yolk sac tumor is rare in adults; however yolk sac elements are frequently seen in tumors with mixed histologic features in adults and thus indicate poor prognosis. The US appearance of yolk sac tumor is usually nonspecific and consists of inhomogeneous mass that may contain echogenic foci secondary to hemorrhage. mass that forms an irregular margin with the tunica albuginea

2.3.16 Yolk sac tumor

2.3.17Choriocarcinoma

Choriocarcinoma is a highly malignant testicular tumor that usually develops in the 2nd and 3rd decades of life. Pure choriocarcinomas are rare and represent only less than 1 percent of all testicular tumors (Woodward et al, 2002). Choriocarcinomas

are composed of both cytotrophoblasts and syncytiotrophoblasts, with the latter responsible for the clinical elevation of human chorionic gonadotrophic hormone level. As microscopic vascular invasion is common in choriocarcinoma, hematogeneous metastasis, especially to the lungs is common (Dogra et al, 2003, as cited in Geraghty et al, 1998). Many choriocarcinomas show extensive hemorrhagic necrosis in the central portion of the tumor; this appears as mixed cystic and solid components (Dogra et al 2003, as cited in Hamm, 1997) at ultrasound.

2.3.18 Teratoma

Although teratoma is the second most common testicular tumor in children, it affects all age groups. Mature teratoma in children is often benign, but teratoma in adults, regardless of age, should be considered as malignant. Teratomas are composed of all three germ cell layers, i.e. endoderm, mesoderm and ectoderm. At ultrasound, teratomas generally form well-circumscribed complex masses. Echogenic foci representing calcification, cartilage, immature bone and fibrosis are commonly seen [Fig.2. 16]. Cysts are also a common feature and depending on the contents of the cysts i.e. serous, mucoid or keratinous fluid, it may present as anechoic or complex structure [Fig.2. 17].

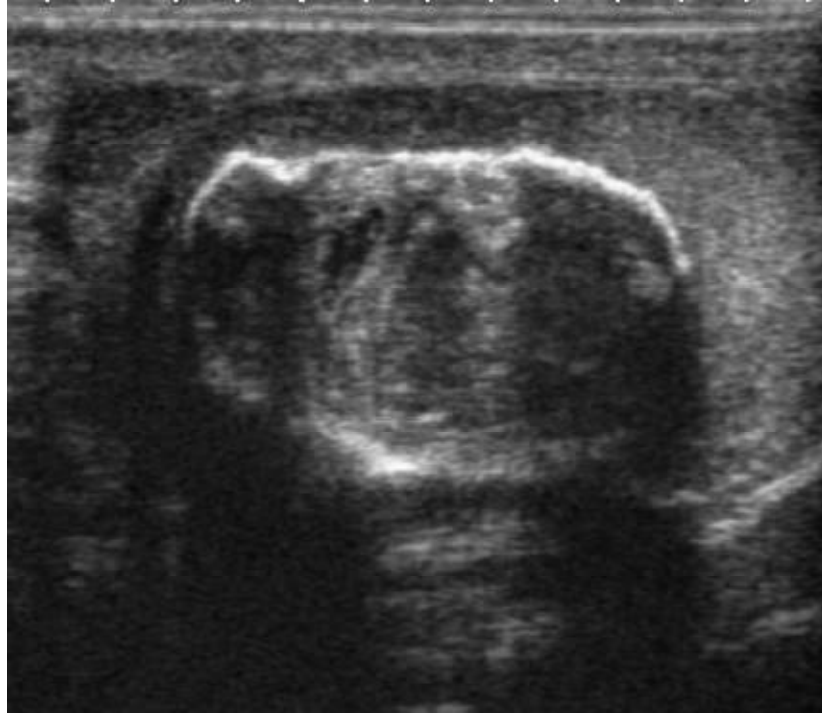


Fig.2.16. Teratoma. A plaque like calcification with acoustic shadow is seen in the testis

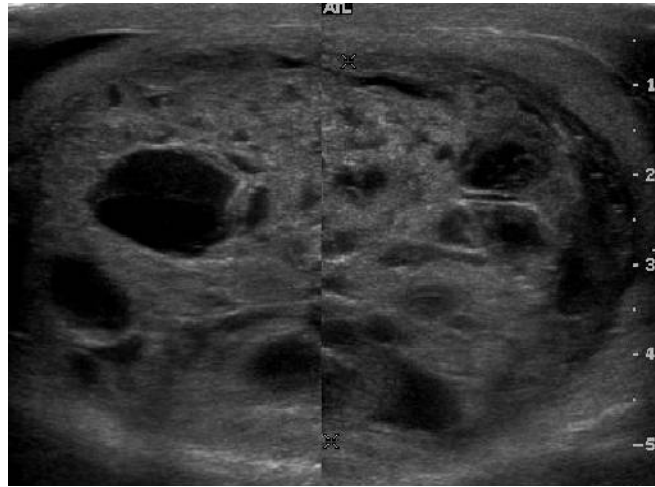
2.3.19 Non-germ cell tumours

2.3.20 Sex cord-stromal tumours

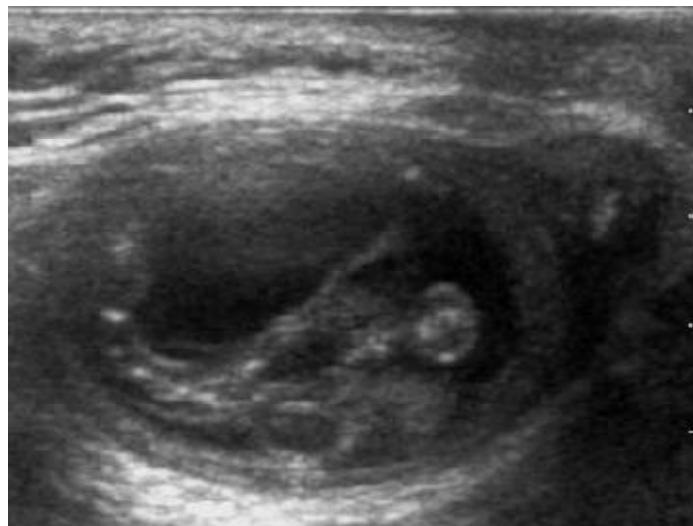
Sex cord-stromal (gonadal stromal) tumors of the testis, account for 4 per cent of all testicular tumors (Dogra et al, 2003). The most common are Leydig and Sertoli cell tumors.

Although the majority of these tumors are benign, these tumors can produce hormonal changes, for example, Leydig cell tumor in a child may produce isosexualvirilization. In adult, it may have no endocrine manifestation or gynecomastia, and decrease in libido may result from production of estrogens. These tumors are typically small and are usually discovered incidentally. They do not have any specific ultrasound appearance but appear as well-defined hypoechoic

lesions. These tumors are usually removed because they cannot be distinguished from malignant germ cell tumors.



(a)



(b)

Fig.2. 17. Mature cystic teratoma. (a) Composite Image. Mature cystic teratoma in a 29 year-old man.

Longitudinal sonography image of the right testis shows a multilocular cystic mass. (b)

Mature cystic teratoma in a 6 year-old boy. Longitudinal sonography of the right testis shows a cystic mass contains calcification with no obvious acoustic shadow

Leydig cell tumors are the most common type of sex cord–stromal tumor of the testis, accounting for 1%–3% of all testicular tumors. They can be seen in any age group, they are generally small solid masses, but they may show cystic areas, hemorrhage, or necrosis (Woodward et al 2002, as cited in Ulbright et al, 1999).

Their sonographic appearance is variable and is indistinguishable from that of germ cell tumors (Woodward et al 2002, as cited in Avery et al, 1991). Sertoli cell tumors are less common, constituting less than 1% of testicular tumors. They are less likely than Leydig cell tumors to be hormonally active, but gynecomastia can occur (Woodward et al 2002, as cited in Ulbright et al, 1999). Sertoli cell tumors are typically well-circumscribed, unilateral, round to lobulated masses.

2.3.21 Lymphoma

Clinically lymphoma can manifest in one of three ways: as the primary site of involvement, or as a secondary tumor such as the initial manifestation of clinically occult disease or recurrent disease. Although lymphomas constitute 5% of testicular tumors and are almost exclusively diffuse non-Hodgkin B-cell tumors, only less than 1 % of non-Hodgkin lymphomas involve the testis (Doll and Weiss 1986).

Patients with testicular lymphoma are usually old aged around 60 years of age, present with painless testicular enlargement and less commonly with other systemic symptoms such as weight loss, anorexia, fever and weakness. Bilateral testicle involvements are common and occur in 8.5% to 18% of cases (Dogra et al, 2003, as cited in Horstman et al, 1992). At sonography, most lymphomas are homogeneous and diffusely replace the testis [Fig. 2.18].

However focal hypoechoic lesions can occur, hemorrhage and necrosis are rare. At times, the sonographic appearance of lymphoma is indistinguishable from that of the germ cell tumors [Fig. 2. 19], then the patient's age at presentation, symptoms, and medical history, as well as multiplicity and bilaterality of the lesions, are all important factors in making the appropriate diagnosis.

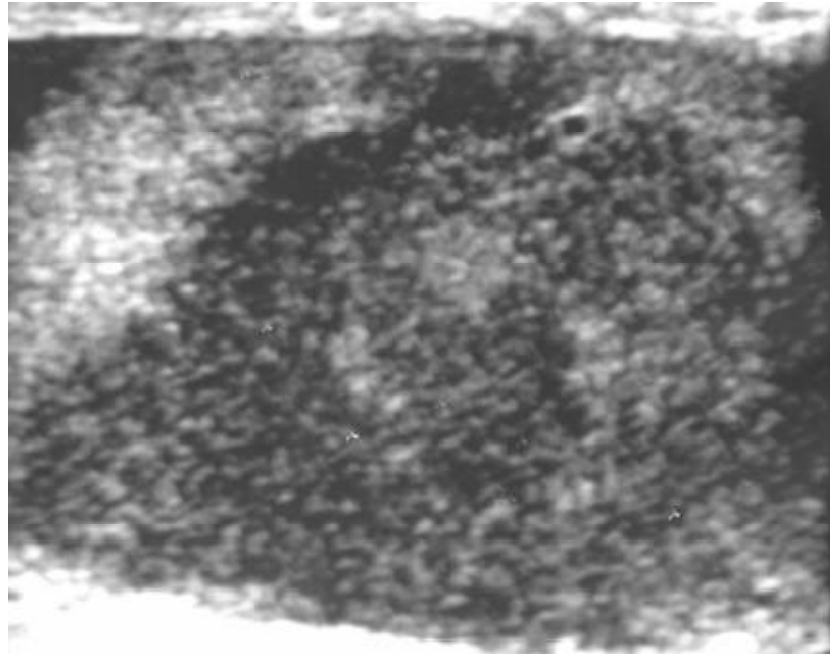


Fig.2. 18.Lymphoma.Lymphoma in a 61 year-old man. Longitudinal sonography shows an irregular hypoechoic lesion occupied nearly the whole testis



Fig.2.19. Primary Lymphoma. Longitudinal sonography of a 64 year-old man shows a lymphoma mimicking a germ cell tumor

2.3.22 Leukemia

Primary leukemia of the testis is rare. However due to the presence of blood-testis barrier, chemotherapeutic agents are unable to reach the testis, hence in boys with acute lymphoblastic leukemia, testicular involvement is reported in 5% to 10% of patients, with the majority found during clinical remission (Dogra et al, 2003). The sonographic appearance of leukemia of the testis can be quite varied, as the tumors may be unilateral or bilateral, diffuse or focal, hypoechoic or hyperechoic (Woodward et al, 2002). These findings are usually indistinguishable from that of the lymphoma [Fig. 2.20].

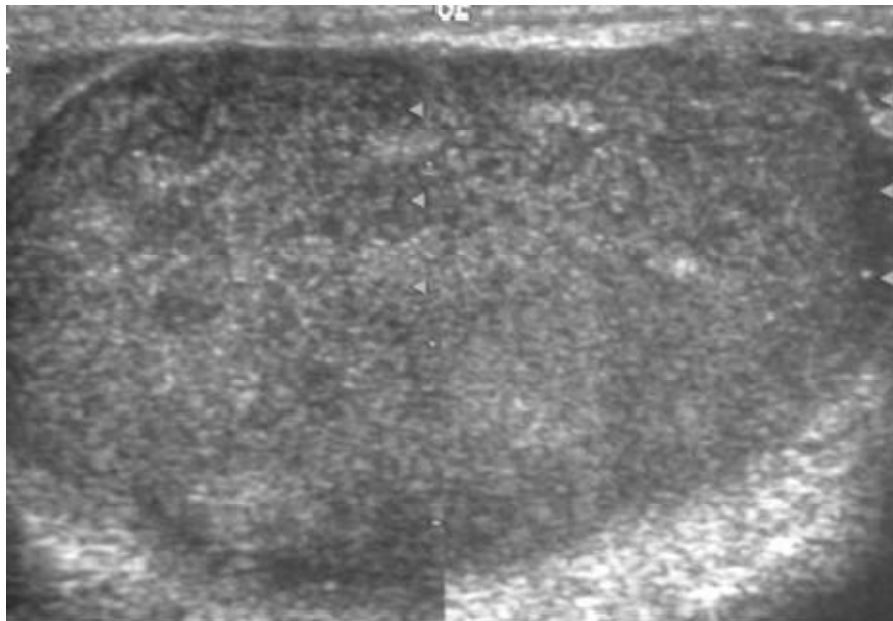


Fig.2.20. Leukemia. Diffuse hypoechoic infiltrative lesions are seen involving the whole testis, indistinguishable from that of the lymphoma

2.3.23 Epidermoid cyst

Epidermoid cysts, also known as keratocysts, are benign epithelial tumors which usually occur in the second to fourth decades and accounts for only 1–2% of all intratesticular tumors. As these tumors have a benign biological behavior and with no malignant potential, preoperative recognition of this tumor is important as this will lead to testicle preserving surgery (enucleation) rather than unnecessary orchiectomy.

Clinically, epidermoid cyst cannot be differentiated from other testicular tumors, typically presenting as a non-tender, palpable, solitary intratesticular mass. Tumor markers such as serum beta-human chorionic gonadotropin and alpha-feto protein are negative.

2.3.24 The ultrasound patterns of epidermoid cysts are variable and include:

- i. A mass with a target appearance, i.e. a central hypoechoic area surrounded by an echolucent rim (Mak et al, 2007a, as cited in Maxwell & Mamtara, 1990);
- ii. An echogenic mass with dense acoustic shadowing due to calcification; (Mak et al, 2007a, as cited in Meiches & Nurenberg 1991);
- iii. A well-circumscribed mass with a hyperechoic rim (Mak et al, 2007a, as cited in Cohen 1984);
- iv. Mixed pattern having heterogeneous echotexture and poor-defined contour (Mak et al, 2007a, as cited in Atchley & Dewbury, 2000) and
- v. An onion peel appearance consisting of alternating rings of hyperechogenicities and hypoechogenicities (Mak et al, 2007a, as cited in Malvica, 1993).

However, these patterns, except the latter one, may be considered as non-specific as heterogeneous echotexture and shadowing calcification can also be detected in malignant testicular tumors (Mak et al, 2007a). The onion peel pattern of epidermoid cyst [Fig. 2. 21] correlates well with the pathologic finding of multiple

layers of keratin debris produced by the lining of the epidermoid cyst. This sonographic appearance should be considered characteristic of an epidermoid cyst and corresponds to the natural evolution of the cyst.

Absence of vascular flow is another important feature that is helpful in differentiation of epidermoid cyst from other solid intratesticular lesions.

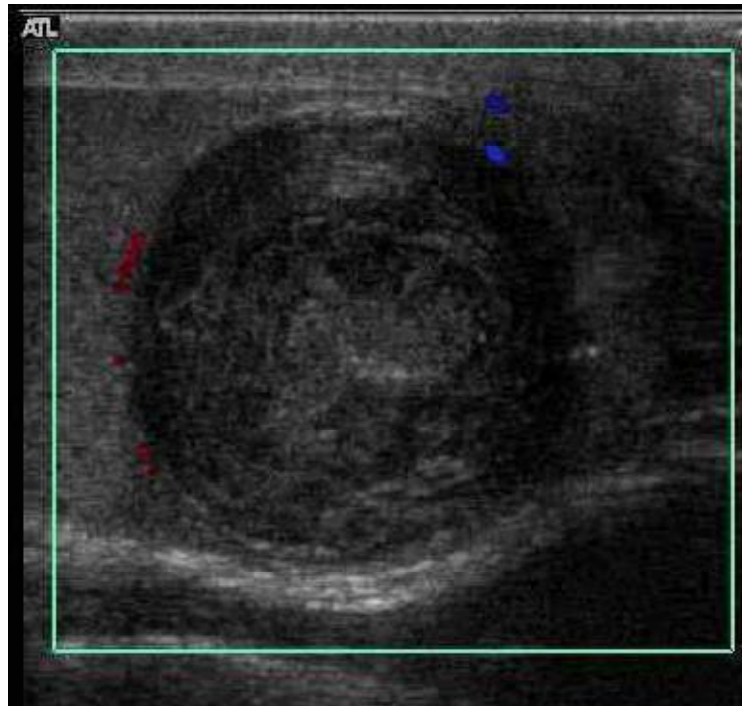


Fig.2. 21.Epidermoid cyst. Onion peel appearances of the tumor together with absence of vascular flow are typical findings of epidermoid cyst

2.3.25 Extratesticular tumors

Although most of the extratesticular lesions are benign, malignancy does occur; the most common malignant tumors in infants and children are rhabdomyosarcomas (Mak et al 2004, as cited in Green, 1986). Other malignant tumors include liposarcoma, leiomyosarcoma, malignant fibrous histiocytoma and mesothelioma.

2.3.26 Rhabdomyosarcoma

Rhabdomyosarcoma is the most common tumor of the lower genitourinary tract in children in the first two decades, it may develop anywhere in the body, and 4%

occur in the paratesticular region (Mak et al 2004, as cited in Hamilton et al, 1989) which carries a better outcome than lesions elsewhere in the genitourinary tract. Clinically, the patient usually presents with nonspecific complaints of a unilateral, painless intrascrotal swelling not associated with fever. Transillumination test is positive when a hydrocele is present, often resulting in a misdiagnosis of epididymitis, which is more commonly associated with hydrocele.

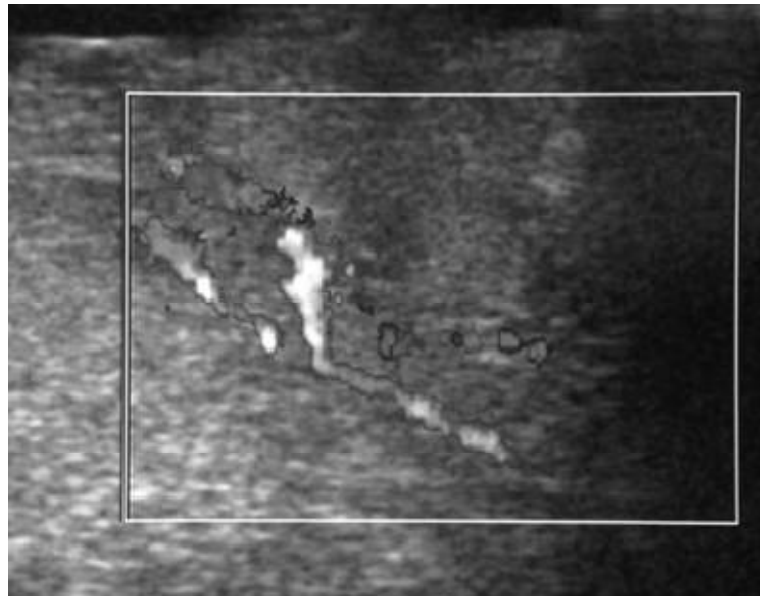
The ultrasound findings of paratesticular rhabdomyosarcoma are variable. It usually presents as an echo-poor mass [Fig. 2.22a] with or without hydrocele (Mak et al 2004a, as cited in Solvetti et al, 1989). With color Doppler sonography [Fig. 2.22b] these tumors are generally hypervascular (Mak et al, 2004a).

2.3.27 Mesothelioma

Malignant mesothelioma is an uncommon tumor arising in body cavities lined by mesothelium. The majority of these tumors are found in the pleura, peritoneum and less frequently pericardium. As the tunica vaginalis is a layer of reflected peritoneum, mesothelioma can occur in the scrotal sac. Although trauma, herniorrhaphy and long term



(a)



(b)

Fig.2. 22.Rhabdomyosarcoma (Reproduced with permission from British Institute of Radiology, British Journal of Radiology 2004; 77: 250–252). (a) Longitudinal section (composite image) of high resolution ultrasound of a 14 year-old boy shows a well defined hypoechoic extratesticular mass is found in the left scrotum, hydrocele is also present. (b)Color Doppler ultrasound shows that the mass is hypervascular hydrocele (Mak et al, 2004b, as cited in Gurdal&Erol, 2001) have been considered as the predisposing factors for development of malignant mesothelioma, the only well established risk factor is asbestos exposure (Boyum&Wasserman, 2008). Patients with malignant mesothelioma of the tunica vaginalis frequently have a progressively enlarginghydrocele and less frequently a scrotal mass, rapid re-accumulation of fluid after aspirationraises the suggestion of malignancy (Mak et al, 2004b, as cited in Wolanske& Nino-Murcia, 2001).

The reported ultrasound features of mesothelioma of the tunica vaginalis testis are variable.

2.3.28 Hydrocele, either simple or complex is present and may be associated with:

- (1) Multipleextratesticular papillary projections of mixed echogenicity (Boyum& Wasserman 2008, ascited in Fields et al, 1992);
- (2) multiple extratesticular nodular masses of increasedechogenicity (Boyum& Wasserman, 2008, as cited in Bruno et al, 2002 and Tyagi et al, 1989);
- (3) focal irregular thickening of the tunica vaginalis testis (Bruno et al, 2002);
- (4) a simple hydrocele as the only finding (Boyum& Wasserman, 2008, as cited in Jalon et al, 2003) and
- (5) A single hypoechoic mass located in the epididymal head (Boyum& Wasserman, 2008; Mak et al, 2004b). With color Doppler sonography, mesothelioma is hypovascular [Fig.2. 23] (Bruno et al, 2002; Mak et al, 2004; Wang et al, 2005).

2.3.29 Leiomyoma

Leiomyomas are benign neoplasms that may arise from any structure or organ containing smooth muscle. The majority of genitourinary leiomyomas are found in the renal capsule, but this tumor has also been reported in the epididymis, spermatic cord, and tunica albuginea. Scrotal leiomyomas have been reported in patients from the fourth to ninth decades of life with most presenting during the fifth decade. These tumors are generally slow growth and asymptomatic. The sonographic features of leiomyomas have been reported as solid hypoechoic or heterogeneous masses that may or may not contain

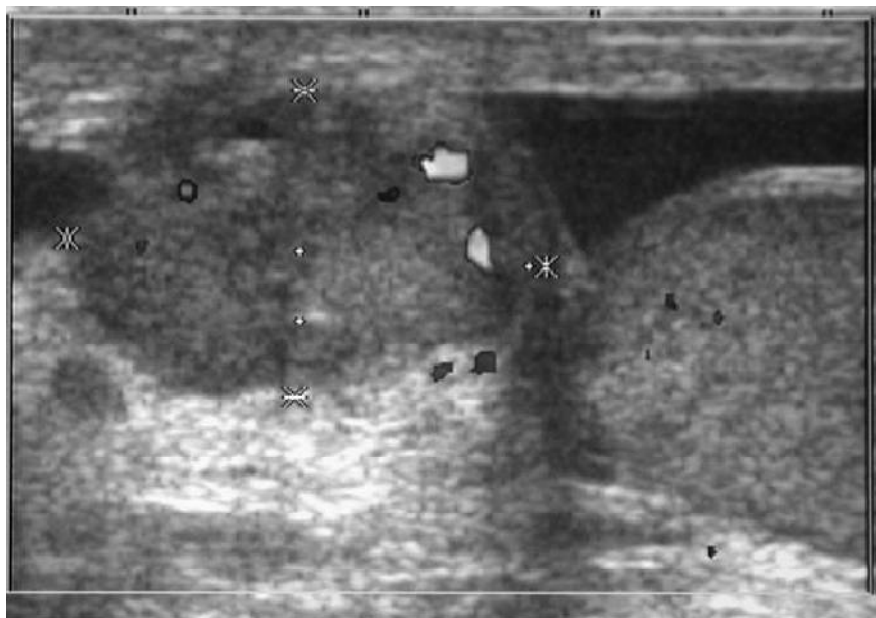


Fig. 2.23. Mesothelioma arising from the tunica vaginalis (Reproduced with permission from British Institute of Radiology, British Journal of Radiology 2004;77:780–781).

Color Doppler ultrasound demonstrates a well-defined hypoechoic nodule occupying the left epididymal head, with a few areas of color flow demonstrated. The left testis is intact with no focal nodule detected. Hydrocele is also present shadowing calcification (Mak et al, 2004, as cited in Hricak & Filly, 1983

&Leonhardt, 1993). Other findings include whorl shaped configuration [Fig. 2.24a] of the nodule (Mak et al,2004) and multiple, narrow areas of shadowing not cast by calcifications [Fig. 2.24b], but corresponding to transition zones between the various tissue components of the mass (Maket al, 2004, as cited in Hertzberg et al, 1996) are characteristic of leiomyoma and may helpdifferentiate it from other scrotal tumors.



(a)



(b)

Fig.2. 24. Leiomyoma arising from tunica albuginea (Reproduced with permission from John Wiley and Sons publishing company License number 2643411100095, Journal of Clinical Ultrasound 2004; 32:309–311). (a) Montage of 2 contiguous sonograms of a 67 year-old man shows a well-defined extratesticular mass with a whorl-shaped echotexture. (b) Color Doppler sonogram shows no internal vascularity. Note the presence of multiple shadows not associated with echogenic foci in the mass

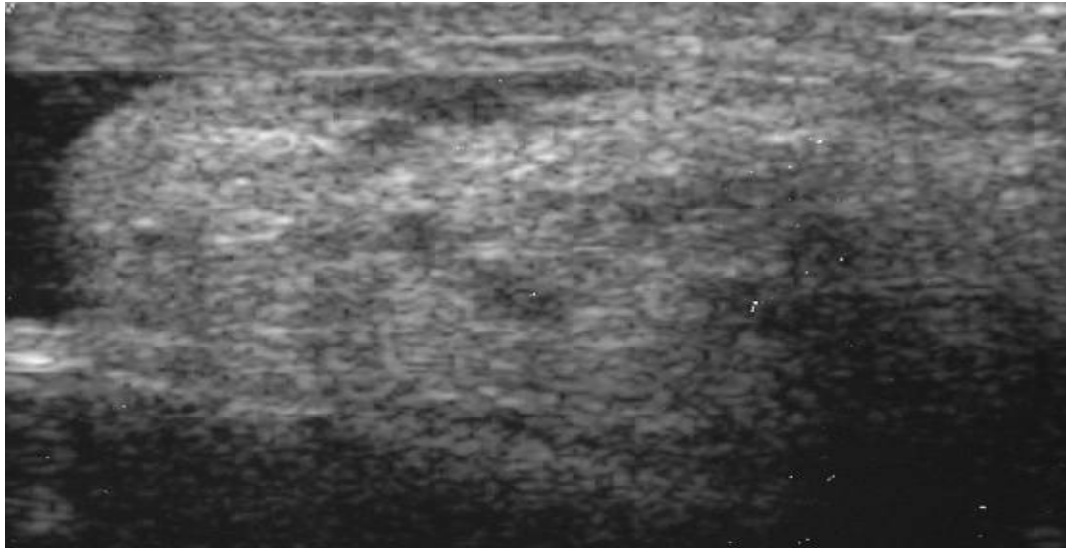
2.3.30 Fat containing tumors

2.3.31 Lipoma

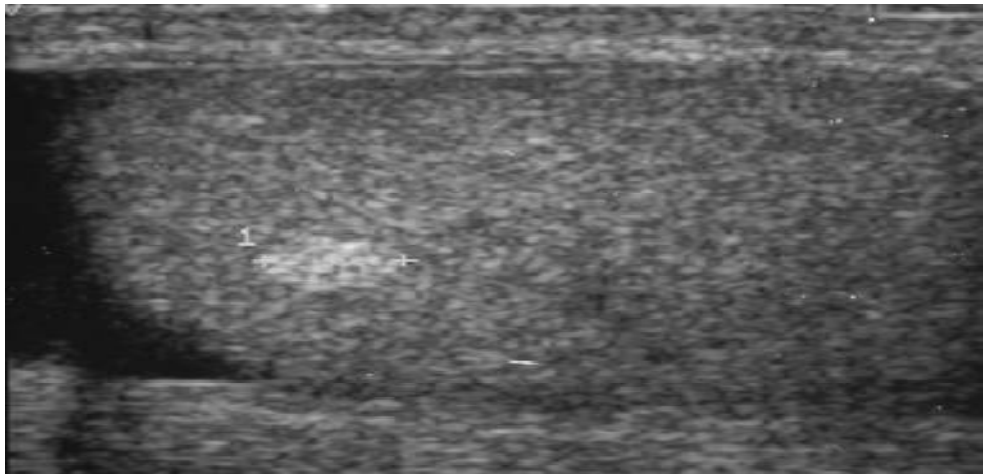
Lipoma is the most common non testicular intrascrotal tumor. It can be divided into 3 types depending upon the site of origination and spread:

1. Originate in the spermatic cord with spread to the scrotum;
2. Originate and develop within the cord (most common type) and
3. Originate and develop within the scrotum (Rosenberg & Williamson, 1989).

At ultrasound, lipoma is a well-defined, homogeneous, hyperechoic paratesticular lesion of varying size [Fig. 2. 25]. The simple finding of an echogenic fatty mass within the inguinal canal, while suggestive of a lipoma, should also raise a question of fat from the omentum secondary to an inguinal hernia. However lipomas are well-defined masses, whereas herniated omentum appears to be more elongated and can be traced to the inguinal area, hence scanning along the inguinal canal as well as the scrotum is necessary to make the differential diagnosis. Magnetic resonance imaging and computerized tomography are helpful in doubtful cases.



(a)



(b)

Fig.2.25. Lipoma at spermatic cord and testicle. (a) Longitudinal scrotal sonography of a 61 year-old patient shows a well defined hyperechoic nodule is seen in the scrotum. (b) Scrotal sonography of the same patient shows a hyperechoic nodule in the left testis, pathology proved that this is a lipoma too

2.3.32 Liposarcoma

Malignant extratesticular tumors are rare. Most of the malignant tumors are solid and have nonspecific features on ultrasonography. The majority of the malignant extratesticular tumors arise from spermatic cord with liposarcoma being the most common in adults (Woodward et al, 2003). On gross specimen, liposarcoma is a solid, bulky lipomatous tumor with heterogeneous architecture, often containing areas of calcification (Bostwick & Eble, 1997). Although the sonographic appearances of liposarcoma are variable and nonspecific, it still provides a clue about the presence of lipomatous matrix. Echogenic areas corresponding to fat often associated with poor sound transmission and areas of heterogeneous

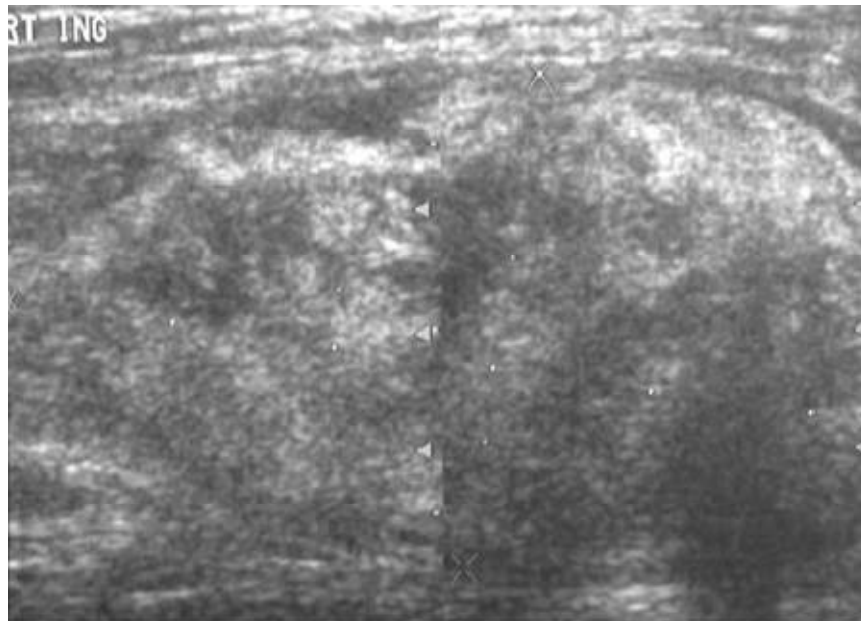


Fig.2.26. Liposarcoma.

A heterogeneous mass consists of an upper hyperechoic portion corresponds to lipomatous matrix and areas of hypoechogenicity corresponds to nonlipomatous component is seen echogenicity corresponding to nonlipomatous component are present [Fig.2. 26]. Some liposarcomas may also mimic the sonographic

appearance of lipomas [Fig. 2.27] and hernias that contain omentum, but lipomas are generally smaller and more homogeneous and hernias are elongated masses that can often be traced back to the inguinal canal. CT and MR imaging are more specific, as they can easily recognize fatty component along with other soft tissue component more clearly than ultrasound.

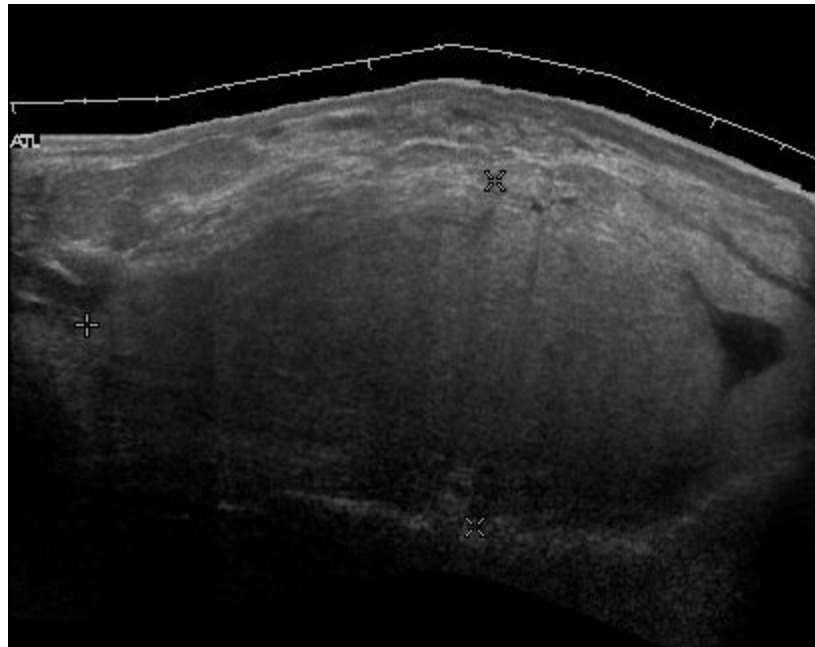


Fig. 2.27. Liposarcoma mimicking lipoma. A homogeneous hypoechoic mass presents with the same appearance of lipoma, rapid growth of this tumors grants surgical intervention with pathology proved to be well differentiated liposarcoma

2.3.33 Adenomatoid tumor

Adenomatoid tumors are the most common tumors of the epididymis and account for approximately 30% of all paratesticular neoplasms, second only to lipoma (Bostwick & Eble, 1997). They are usually unilateral, more common on the left side, and usually involve the epididymal tail. Adenomatoid tumor typically occurs in men during the third and fourth decades of life. Patients usually present with a painless scrotal mass that is smooth, round and well circumscribed on palpation. They are believed to be of mesothelial origin and are universally benign. Their

sonographic appearance is that of a round shaped, well-defined, homogeneous mass with echogenicity ranging from hypo- to iso- to hyperechoic [Fig.2. 28] (Mak et al, 2001).

2.3.34 Fibrouspseudotumor

Fibrous pseudotumors, also known as fibromas are thought to be reactive, nonneoplastic lesions. They can occur at any age, about 50% of fibromas are associated with hydrocele, and 30% are associated with a history of trauma or inflammation (Akbar et al, 2003). Although the exact cause of this tumor is not completely understood, it is generally believed that these lesions represent a benign reactive proliferation of inflammatory and fibrous tissue, in response to chronic irritation (Garriga et al, 2009).

Sonographic evaluation generally shows one or more solid nodules arising from the tunica vaginalis, epididymis, spermatic cord and tunica albuginea [Fig. 2.29]. A hydrocele is frequently present too. The nodules may appear hypoechoic or hyperechoic, depending on the amount of collagen or fibroblast present (Garriga et al, 2009, as cited in Tobias-Machado et al, 2000).

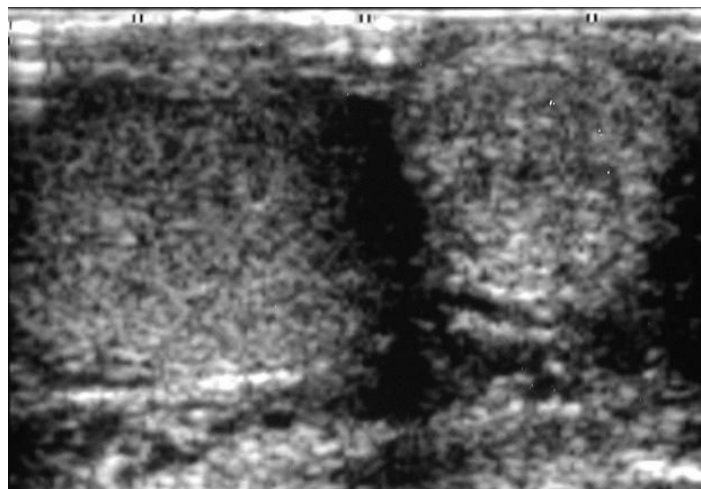


Fig. 2.28. Adenomatoid tumor at epididymis. A nodule that is isoechoic to the testis is seen occupying nearly the entire epididymal tail

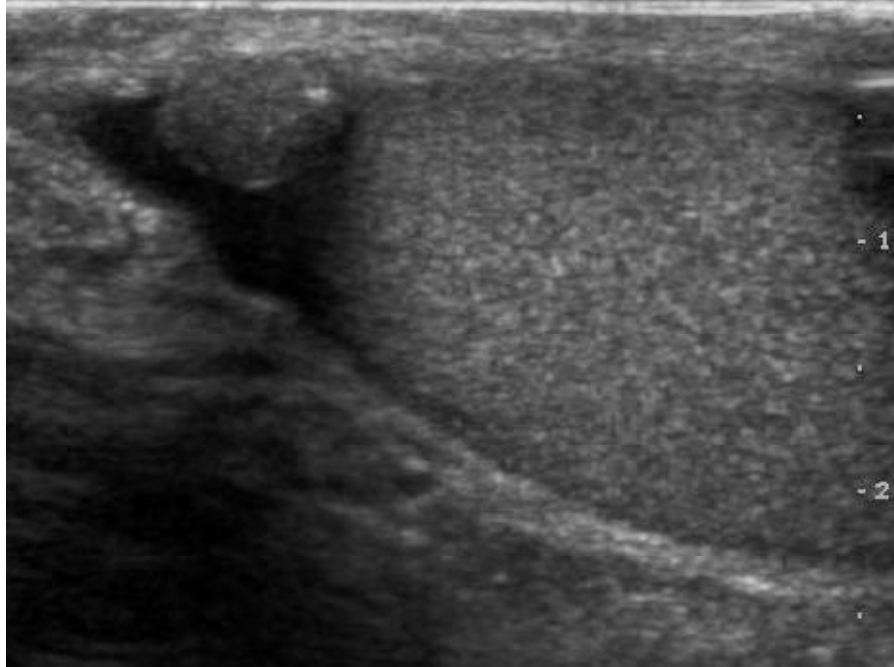


Fig.2. 29.Fibrous pseudotumor. A homogeneous hypoechoic nodular lesion is seen attached to the tunica associated with minimal amount of hydrocele



Fig.2.30. Fibrous pseudotumor. With color Doppler, a little vascular flow is seen in this fibrous pseudotumor

Acoustic shadowing may occur in the absence of calcification due to the dense collagen component of this tumor. With color Doppler sonography, a small to moderate amount of vascularity may be seen (Garriga et al 2009, as cited in Germaine and Simerman, 2007) [Fig.2.30].

2-4 Equipments and techniques

Ultrasound scanners consist of a console containing a computer and electronics, a video display screen and a transducer that is used to do the scanning. The transducer is a small hand-held device that resembles a microphone, attached to the

scanner by a cord. The transducer sends out inaudible high frequency sound waves into the body and then listens for the returning echoes from the tissues in the body.



Fig (2-31) Ultrasound Equipment

The ultrasound image is immediately visible on a video display screen that looks like a computer or television monitor. The image is created based on the amplitude

(loudness), frequency (pitch) and time it takes for the ultrasound signal to return from the area of the patient being examined to the transducer (the device used to examine the patient), as well as the type of body structure and composition of body tissue through which the sound travels. A small amount of gel is put on the skin to allow the sound waves to travel back and forth from the transducer.



Fig (2-32) linear transducer

In order to perform a scrotal sonogram, most commonly a linear small parts transducer is used.

In an ultrasound examination, a transducer both sends the sound waves and receives the echoing waves.

When the transducer is pressed against the skin, it directs small pulses of inaudible, high-frequency sound waves into the body. As the sound waves bounce off internal organs, fluids and tissues, the sensitive microphone in the transducer records tiny changes in the sound's pitch and direction. These signature waves are instantly measured and displayed by a computer, which in turn creates a real-time

picture on the monitor. One or more frames of the moving pictures are typically captured as still images. Small loops of the moving “real time” images may also be saved.

Patient positioned lying face-up on an examination table that can be tilted or moved.

After you are positioned on the examination table, the radiologist or sonographer will apply a warm water-based gel to the area of the body being studied. The gel will help the transducer make secure contact with the body and eliminate air pockets between the transducer and the skin that can block the sound waves from passing into your body. The transducer is placed on the body and moved back and forth over the area of interest until the desired images are captured.

There is usually no discomfort from pressure as the transducer is pressed against the area being examined. However, if scanning is performed over an area of tenderness, you may feel pressure or minor pain from the transducer.

Once the imaging is complete, the clear ultrasound gel will be wiped off your skin. Any portions that are not wiped off will dry to a powder. The ultrasound gel does not stain or discolor clothing.

Ultrasound examinations are painless and easily tolerated by most patients.

Ultrasound imaging of the scrotum is usually completed within 15 to 30 minutes, though sometimes more time is necessary.

2.5 Previous studies

D'Andrea et al.(2013)studied The acute scrotum is a medical emergency . The acute scrotum is defined as scrotal pain, swelling, and redness of acute onset. Scrotal abnormalities can be divided into three groups , which are extra-testicular lesion, intra-testicular lesion and trauma. This is a retrospective analysis of 164 ultrasound examination performed in patient arriving in the emergency room for scrotal pain.The objective of this article is to familiarize the reader with the US features of the most common and some of the least common scrotal lesions.

Ringert.(1998) studied The Acute scrotal swelling is a potential urologic emergency. There are many conditions which may present with scrotal swelling including spermatic cord torsion, torsion of testicular appendages, epididymitis, orchitis, incarcerated scrotal hernia, hydrocele, varicocele, trauma, tumor and testicular pain in vasculitis syndromes such as Schoenlein-Hennochpurpura. Testicular torsion is the most important condition that must be proven or ruled out to avoid loss of testicular function. History, physical examination and perhaps color-coded doppler-sonography are the tools to diagnose torsion. Using these tools, three diagnostic categories will be defined: Torsion, non-torsion or equivocal diagnosis. In every doubtful case scrotal evaluation is done surgically. Non-torsion is treated according to the different diseases.

Blaivas. et al.(2001) studied The Acute scrotal pain is not a rare emergency department (ED) complaint. Traditional reliance on medical history and physical examination can be precarious as signs and symptoms can overlap in various etiologies of acute scrotal pain.

To determine the accuracy with which emergency physicians (EPs) using bedside ultrasonography are able to evaluate patients presenting to the ED with acute scrotal pain.

This study suggests that EPs using bedside ultrasonography are able to accurately diagnose patients presenting with acute scrotal pain. In addition, they appear able to differentiate between surgical emergencies, such as testicular torsion, and other etiologies.

Tumeh et al.(1991)studied the patient with acute scrotal pain. Until recently, scintigraphy was the initial procedure of choice in most patients, as it was the only noninvasive technique for determining integrity of blood flow to the testicle. Ultrasound was valuable when the scintiscan was inconclusive or in the setting of scrotal trauma. With the advent of color Doppler sonography, information about both structure and blood flow can be obtained by means of a single imaging study. If initial promising results with this newer technique are borne out, color Doppler is likely to become the primary diagnostic test in patients with acute scrotal pain. The role of MRI and MRS has yet to be defined.

Fitzgerald et al .(1992) studied The Color Doppler sonography (CDS) was used to evaluate 35 adult males with acute scrotal discomfort. Correlative nuclear scintigraphy was performed in 15 patients. Surgical correlation was available in 10 patients with clinical follow-up in the remaining 25. The complete absence of intratesticular color flow was used as our criterion for testicular ischemia. This was found to be 100% sensitive and 100% specific in 8 patients with surgically confirmed testicular ischemia. Spontaneous detorsion was noted in one patient with hyperemia demonstrated by color imaging. Increased color flow was found in 20 patients with the clinical impression of scrotal inflammation. Nuclear scintigraphy and color Doppler imaging had 100% agreement in 15 patients. Color Doppler sonography is a useful and highly accurate diagnostic method in the evaluation of patients with the acute scrotal syndrome. Color flow imaging is comparable to nuclear scintigraphy in the diagnosis of testicular ischemia.

Blefari, et al.(1994) studied Forty-five patients with acute scrotal disorders underwent gray-scale and color-Doppler ultrasonography. The aim of the study was to evaluate the role of the US in order to distinguish inflammatory diseases from testicular torsion. Gray-scale with color-Doppler US allows for evaluation of morphologic findings and perfusion and enables accurate diagnosis of most scrotal disorders especially in the earlier clinical observations.

Pavlica, and Barozzi.(2001) studied The scrotum is a superficial structure and clinical examination is frequently not enough for making a specific diagnosis. In acute scrotal pain US can confirm the presumptive clinical diagnosis and provide additional relevant information. In testicular torsion, color-Doppler imaging has a central role since it has become possible to identify it at early stage by showing absence of perfusion in the affected testis before any gray-scale abnormality. Scintigraphy remains a satisfactory alternative in evaluating testicular torsion and should be used when color Doppler is inadequate, raising doubts about the suspected torsion. Diagnosis of torsion of testicular appendages is particularly difficult. Ischemic infarction shows a characteristic pattern at gray-scale and color Doppler imaging, whereas hemorrhagic ischemia may require MRI. Inflammatory diseases of the scrotum can be easily investigated by echo color Doppler and conventional radiography, and CT can be particularly useful in the detection of gas bubbles. In scrotal trauma, scrotal hematoma, hematocele, intratesticular hematoma, and testicular rupture can be identified using gray-scale US with very good reliability. Magnetic resonance imaging is indicated when a small tear of tunica albuginea is suspected but not visualized on US.

Abul, et al .(2005) studied Forty patients who were hospitalized between January 2002 and December 2002 for acute scrotum were studied with respect to history,

physical examination, blood tests, urine analysis including culture, and scrotal ultrasonography with color Doppler study.

The results show that a careful clinical evaluation, by an experienced examiner, provides the correct diagnosis in acute scrotum rather than ultrasonography. It is of utmost importance to exclude testicular torsion in those who are younger than 16 years and whose pain duration is less than 24 h.

Iannicelli et al .(2013) studied the evaluation of scrotal disease. It provides high anatomical detail and in most cases, it is essential to enable a correct diagnosis and to obtain the right management of the patient. Color Doppler ultrasonography is a non invasive technique that aids important information about testicular perfusion, necessary in reaching a specific diagnosis in many pathologic conditions; moreover contrast-enhanced ultrasonography (CEUS), recently introduced in the clinical practice, may be considered an additional tool in the classification and differentiation of testicular pathology. The purpose of this review, is to provide the state of the art on the role of ultrasonography in the evaluation of different scrotal pathologies including vaginal process' disorders, acute scrotum, varicocele, hydrocele, chronic inflammatory diseases and testicular tumours.

Chapter three

Material and methods

3.Material and methods

3.1 MATERIAL

3.1.1 Equipment used

High resolution us units with 10-12 MHz linear transducer , acoustic gel, standoff pad may be useful for superficial abnormalities , a towel used to elevate and support the scrotal sac .



Fig 3.1 Ultrasound unit



Fig 3.2 Linear transducer



Fig 3.3 acoustic gel



Fig 3.4 Medical gloves

3.2 Methods

The data of this study collected from 50 patients aged from 2 years old to 84 years old with acute scrotal symptoms, who underwent scrotal ultrasonography (US), were retrospectively reviewed. The clinical presentation, outcome, and US results were analyzed. The presentation symptoms including scrotal pain, painless scrotal mass or swelling, and trauma.

3.2.1 Technique and protocol

The patients have performed an ultrasound examination positioned supine, and a rolled towel or sheet is placed between the legs to support the scrotum. The penis is displaced superiorly or super-laterally with a towel draped over it. Scanning is performed with a high-frequency (8–15-MHz) transducer in sequential sagittal and transverse planes.



Fig 3.5 The penis is displaced superiorly or super-laterally with a towel draped over it.

In cases of marked scrotal enlargement, we used a lower frequency transducer. Scanning of both testes is performed in sagittal and transverse planes with size measurements. Transverse side-by-side images of both testes should be obtained for comparison of echo texture, skin thickness, and color Doppler flow pattern. The epididymis should be imaged on the long and short axes. Color and power Doppler imaging are used to detect flow within the scrotal structures and to confirm symmetric or abnormal flow patterns.

In addition to imaging in longitudinal and transverse planes ,it is helpful to obtain simultaneous images of both testes for comparison.

Color Doppler is uses to evaluate for abnormalities of flow and to differentiate vascular from non vascular lesions .power doppleris useful adjunct to color Doppler in low flow statees.

The valsalva maneuver or scanning in the upright position Should be performed when evaluating for varicoceles.

3.2.2 Image interpretation

Sonographic features that were reviewed included the size and echogenicity of the tumors, presence of cystic areas or calcifications,and distribution pattern of detectable blood flow on color or power Doppler imaging underwent clinical evaluation and scrotal ultrasonography,Scrotal ultrasonography and duplex ultrasonography examination were performed . The patients were collected and reported by radiologists ,Evaluation consist of clinical and sonographic variables(lesion size, location, echogenicity) .

3.2.3 Sample Size &Type

The data of this study collected from 50 patients, all are male , childrens and adults.

3.2.4 Design of the Study

This is retrospective and descriptive hospital base research

3.2.5 Area of the Study

This study was carried out in Zayed military hospital, Abu Dhabi (UAE) United Arab Emirates

3.2.6 Duration of the Study

The study was carried out over duration of 6 months between April 2014 and September 2014,

3.2.7 Data Collection

Data collection according to work sheet (Appendix) includes all above variables data.

3.2.8 Data Analysis Method

Data in corresponding with the thesis analyzed by using Microsoft excel window and stored safely in personal (PC) and pass-warded computer.

3.2.9 Ethical issue

Permission of radiology department and patients arise at the area of the study must be taken to use the patients data.

No patients' details will be published.

Chapter four

Results

This chapter presented the results of the study which include tables and figures based on the methods described in chapter three. The data obtained throughout the study were analyzed and interpreted .summaries of results are generally presented in tables and figures in this chapter.

The following tables and figures presented the results of the study.

Table 4.1 frequency distribution of scrotal diseases

Pathological Findings	Number of patients	percentage
Varicocele	13	26%
Hydrocele	8	16%
Infection	6	12%
Cyst	5	10%
Epididmo-Orcitis	5	10%
Normal	4	8%
Microlithiasis	3	6%
Wall Thickened	3	6%
Ectopic Testical	1	2%
Reactive Lymph node	1	2%
Inguinal Hernia	1	2%

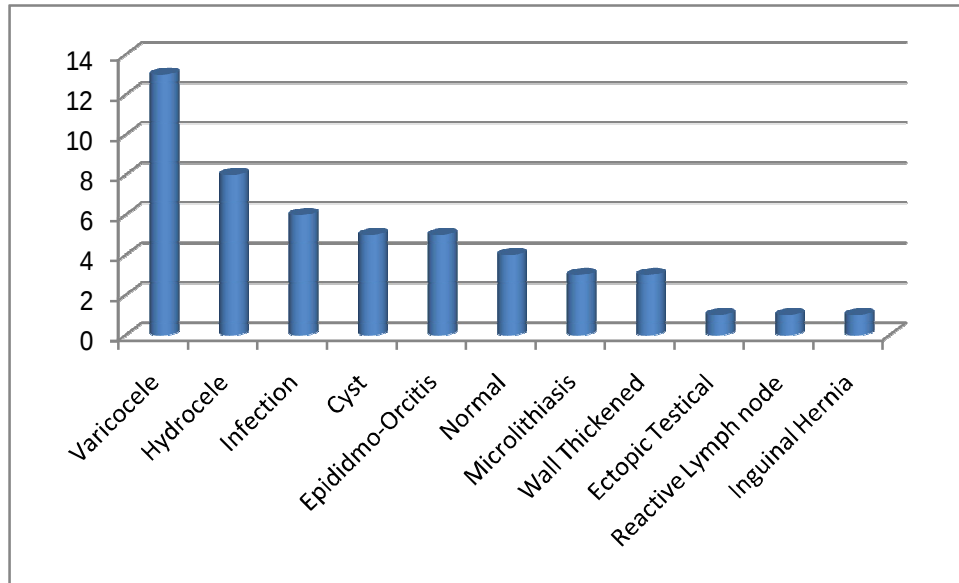


Fig 4.1 shows Ultrasound findings and the number of patients

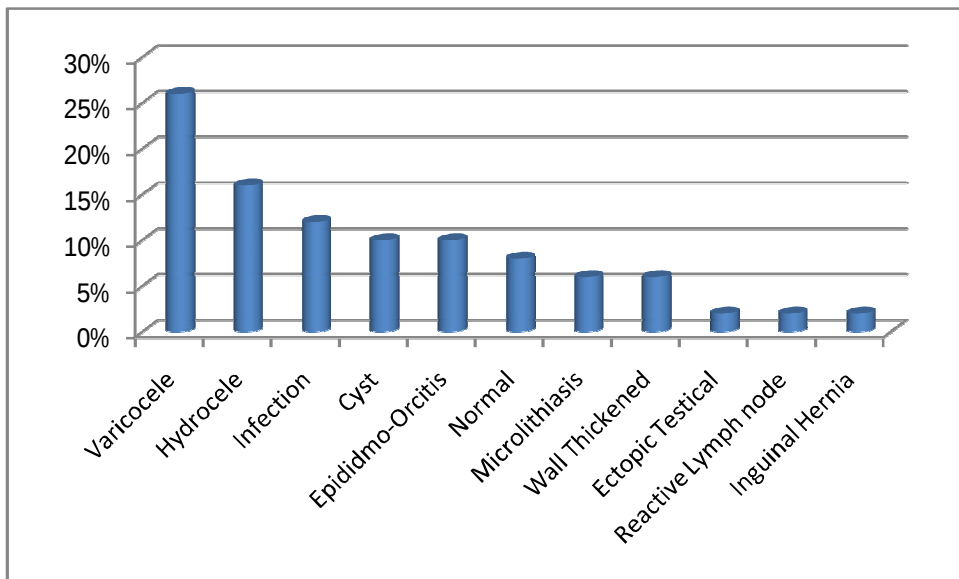


Fig 4.2 shows Ultrasound findings and percentage

Table 4.2 shows Clinical symptoms and sign

Patients	Symptoms	Number Of Patients	Percentage
	scrotal pain	38	76%
	painless scrotal	5	10%
	swelling or mass	7	14%

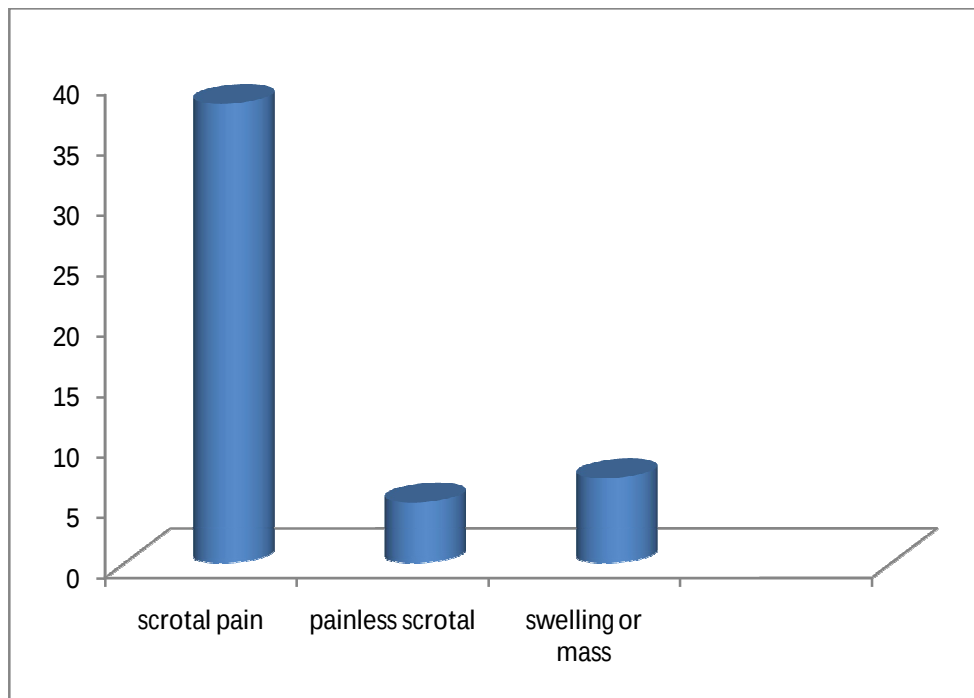


Fig 4.3 shows symptoms versus age

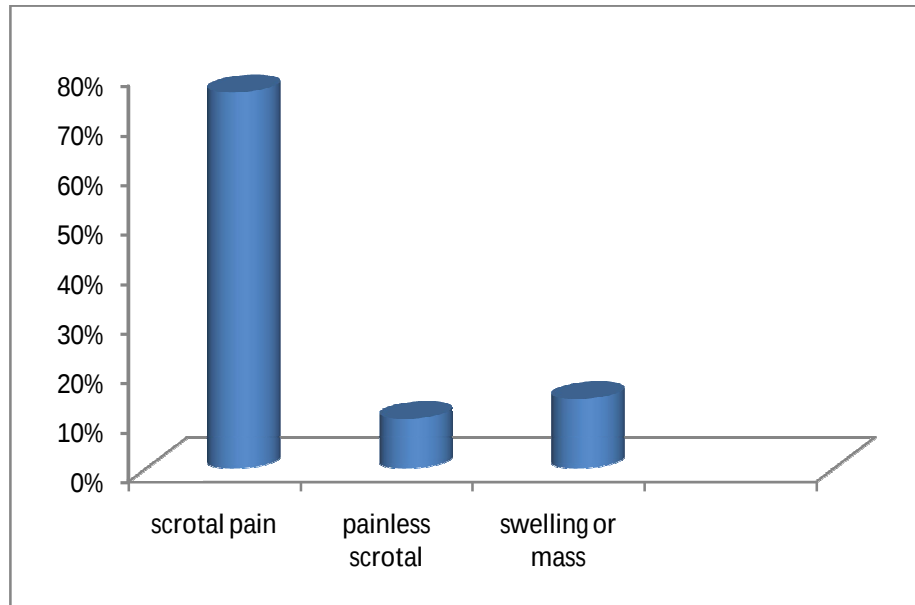


Fig 4.4 shows the symptoms and percentage

Table4.3 shows ultrasound findings and mean age

Ultrasound Findings	Number of patients	Mean age
Varicocele	13	25.92
Hydrocele	8	37.5
Infection	6	32
Cyst	5	28.4
Epididmo-Orcitis	5	34
Normal	4	18.5
Microlithiasis	3	34
Wall Thickened	3	49.33
Ectopic Testical	1	6
Reactive Lymph node	1	25
Inguinal Hernia	1	37

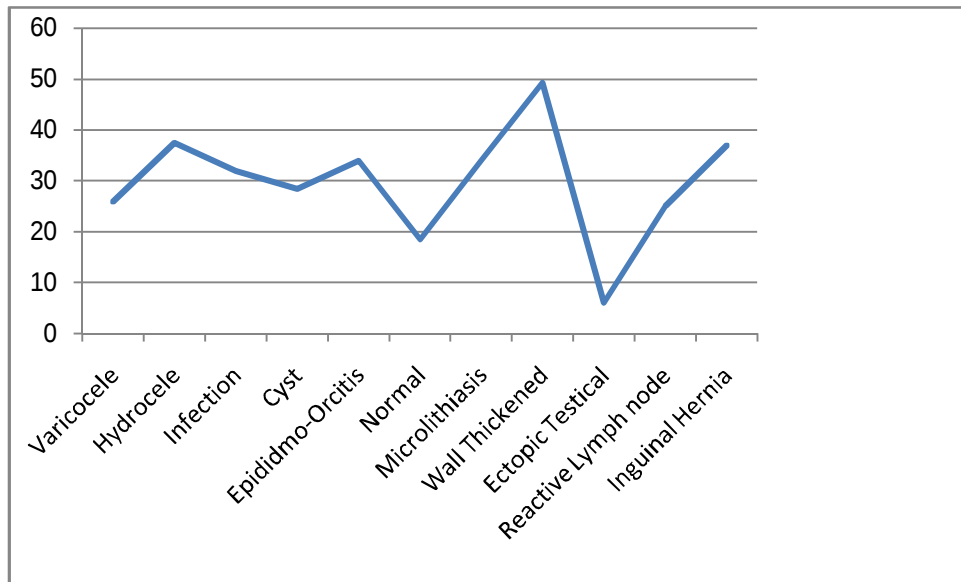


Fig 4.5 Distribution of the mean ages

Chapter five

Discussion, Conclusion and Recommendations

5-1 Discussion

In this study Of 50 patients 38 (76%) presented with scrotal pain, 5 (10%) had painless scrotal ,7 (14%) had swelling or mass,thier age ranged in age from 2 to 84 years (mean 33.66 years) so it found that 13(26%) had varicocele ,thier age ranged from 18 to 47 years (mean25.92 years).8(16%)had hydrocele , their age ranged from 4 to 62 years (mean 37.5 years). 6 (12%) had infection, , their age ranged from 27 to 39 years (mean32 years) .5 (10%) hadcyst, , their age ranged from 17 to 34 years (mean 28.4years) ,5 (10%) had epididmitisorcitis , their age ranged from 9 to 76 years (mean 34 years) . 4 (8%) had normal result, , their age ranged from 2 to 26 years (mean 18.5 years) 3 (6%) had microlithiasis , , their age ranged from 24 to 46 years (mean 34 years) .3 (6%) had scrotal wall thickened the patient of scrotal wall thickened ranged in age from 26 to 84 years (means 49.33 years). 1 (2%) had ectopic testical age of 6 years .1 (2%) had reactive lymph node age of 25 years.1 (2%) had inguinal hernia age of 37 years .Varicocele involves abnormal dilatation of veins in the pampiniform plexus of the spermatic cord and is relatively common.

In the early stages torsion of the gonad appendages can be easily diagnosed by physical examination and Doppler ultrasound of the scrotum. Physical examination at early stages may localize the pain to the upper pole of the testis or epididymis. Torsion of the appendix testis can be easily detected by ultrasound (US) in early

stages of the torsion, as an a-vascular structure, however if the patient arrives to the hospital several days after the initiation of the torsion, probably the whole gonad will be inflamed and the appendages will not be identified sonographically because of the inflammatory background, leading to a non-specific sonographic picture (Strauss et al 1997). Ben Chaim et al (1992). analyzed the surgical findings of 70 children undergoing exploration for acute scrotal pain. Torsion of the gonadal appendix was found in 33 (47%) of the children, as the cause for the inflammation. Hegarty et al (2001). published similar results in a series of 100 consecutive boys with scrotal pain who had scrotal surgical exploration, showing a rate of 32% of gonadal appendage torsion, and 20% gonadal nonbacterial inflammation. McAndrew et al.²¹ found a 70% rate of torsion of the appendix testis in 100 consecutive patients admitted because of scrotal pain during a period of 14 months. In this study 7 % patients represented as testicular torsion.

Most cases are idiopathic; varicoceles are found mainly in adolescents and young adults and are more frequent on the left side. At sonography, the dilated veins appear as tortuous, anechoic, tubular structures along the spermatic cord. On color and pulsed-wave Doppler images, venous flow is better demonstrated during the Valsalva maneuver. Varicocele may affect testicular growth; hence, testicular volumes should be systematically measured and asymmetries assessed with US.

Hydrocele, an abnormal collection of fluid between the visceral and parietal layers of the tunica vaginalis and/or along the spermatic cord, is the most common cause of painless scrotal swelling in children. In the normal scrotum, 1–2 mL of serous fluid may be observed in the potential tunica vaginalis cavity and should not be mistaken for hydrocele. Virtually all hydroceles are congenital in neonates and infants and associated with a patent processus vaginalis, which allows peritoneal fluid to enter the scrotal sac. Up to 50% of acquired hydroceles are due to trauma, and hydroceles may occur in up to 25% of patients with major trauma.

5-2 Conclusion

From this study and previous studies Ultra Sonography is the primary imaging modality for evaluation of the scrotum. B-mode imaging combined with duplex Doppler interrogation provides valuable information in assessment of the acutely painful scrotum in addition to scrotal masses and male infertility.

This study included Patients with normal scrotal anatomy and the use of ultra Sonography in the evaluation and classification of acute scrotal pain, scrotal masses, and male infertility.

The use of ultra Sonography in the evaluation of the scrotum benefits from an understanding of scrotal anatomy and familiarity with potential pitfalls of Color Doppler and pulsed Doppler evaluation .Ultrasound of the testis is still the most common way to diagnose testicular disease.

High-resolution real-time sonography has a high degree of detection, characterization, and localization of scrotal lesions, making it the undisputed modality of choice for imaging the scrotum. It is essential to be familiar with the clinical features of scrotal and extra scrotal pathologic states and to correlate the sonographic findings with the patient's history and symptoms to make an accurate differential diagnosis. Doppler technology enables the assessment of vascular physiologic characteristics, flow, and perfusion, aiding in the evaluation for testicular torsion. In the pediatric population, sonography is helpful in the diagnosis of developmental abnormalities, epididymitis, testicular torsion, and testicular neoplasms. In adults, scrotal sonography is helpful in differentiating cysts from solid neoplasms.

5-3 Recommendations

- The use of CEUS improves characterization of testicular lesions, and confirms lack of vascularity in benign abnormalities such as epidermoid cysts, infarctions, abscesses and changes following trauma.
- Tissue elastography allows further evaluation of the cellular consistency of the abnormality.
- Color Doppler sonography CDS is an indispensable imaging modality for the clinical assessment of patients with acute scrotum the informations it can afford are operator-dependent and have to be supported by the history and physical exam of the patient.
- CDS findings constitute probably an important medico-legal support when the necessity of surgical exploration is excluded; anyway, in presence of a clinical suspicion of testicular torsion, even with an apparently normal CDS, the surgical exploration is recommended.
- Advances in ultra Sonographic spatial and low-contrast resolution have improved our ability to more clearly define diagnoses for the referring clinician and have led to new observations, such as microlithiasis and seminiferous tubule sclerosis, which are currently being investigated and have yet to be fully understood.

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Appendices

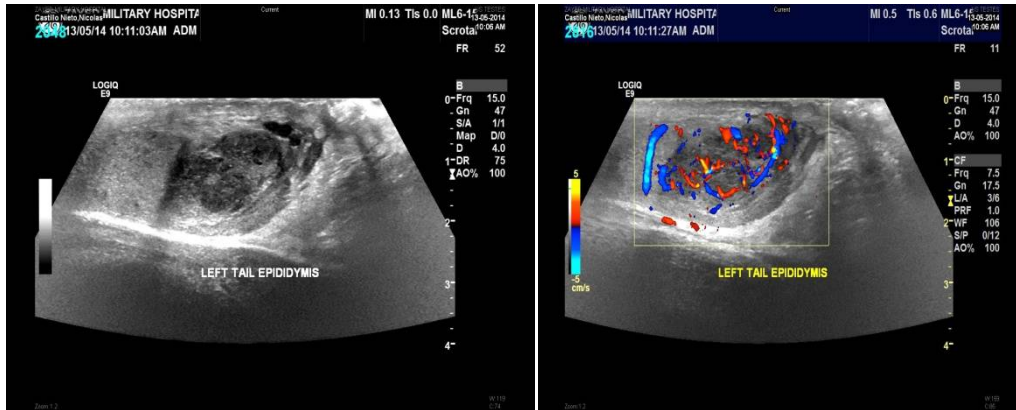


Image (1): shows enlargement with heterogenous echotexture and increase in vascularization of the tail of the left epididymis.

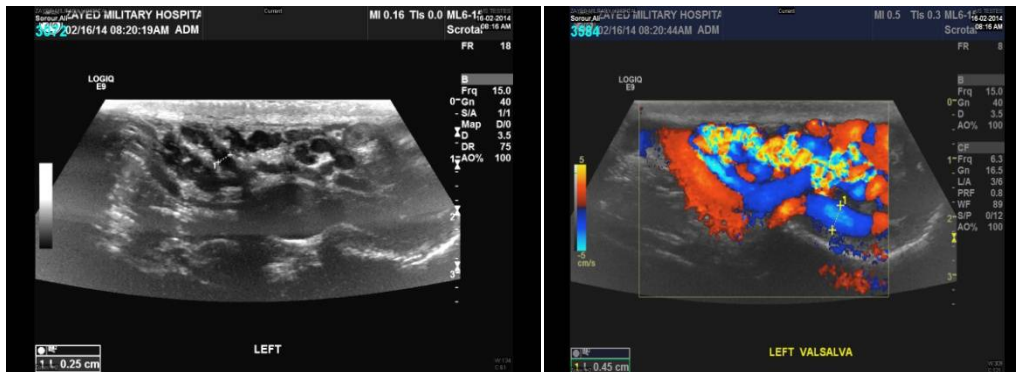


Image (2): shows a moderate (Valsalva=0.4 cm) varicocele in the left peritesticular space.

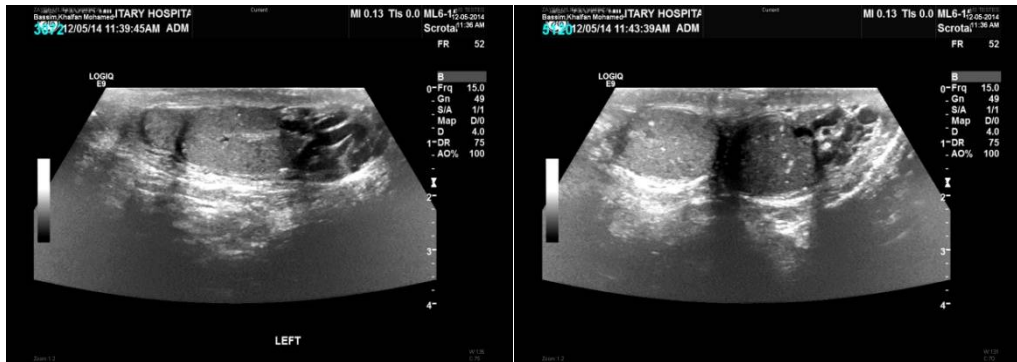


Image (3): shows Microlithiasis are seen in both testes ,there is small varicocele in the left peritesticular space .

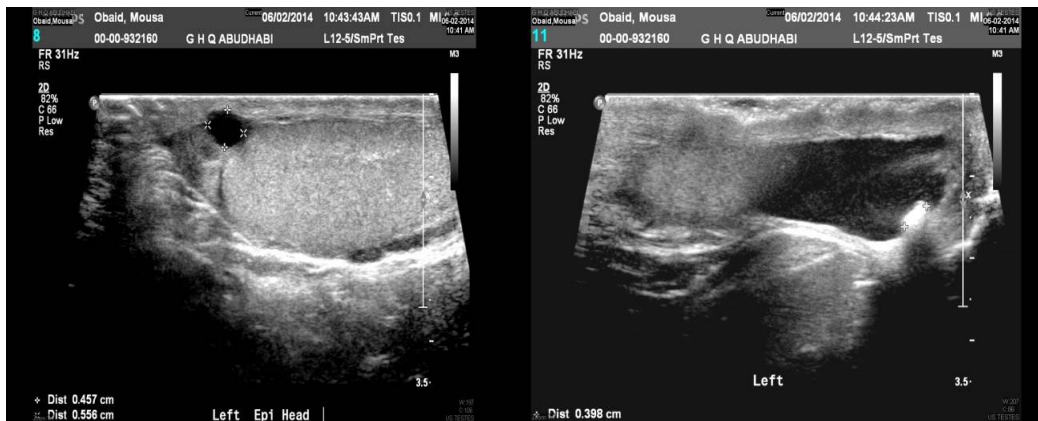


Image (4): shows 0.5×0.5 cm well demarcated cyst in the head of the left epididymis ,evedance of mild hydrocele with specks of calcification in the scrotal wall noted .

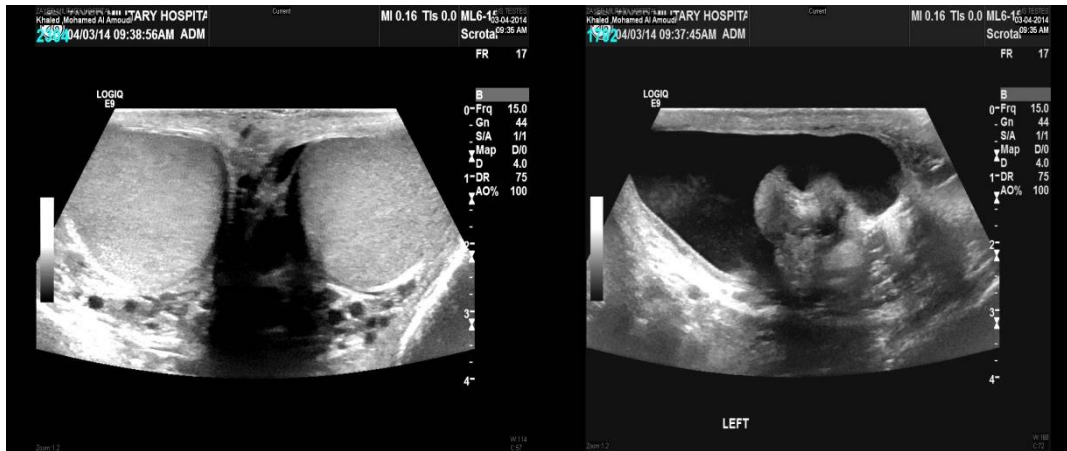


Image (5): shows Both testes maintained outline and contour with preserved parenchymal echogenecity .left minimal hydrocele .

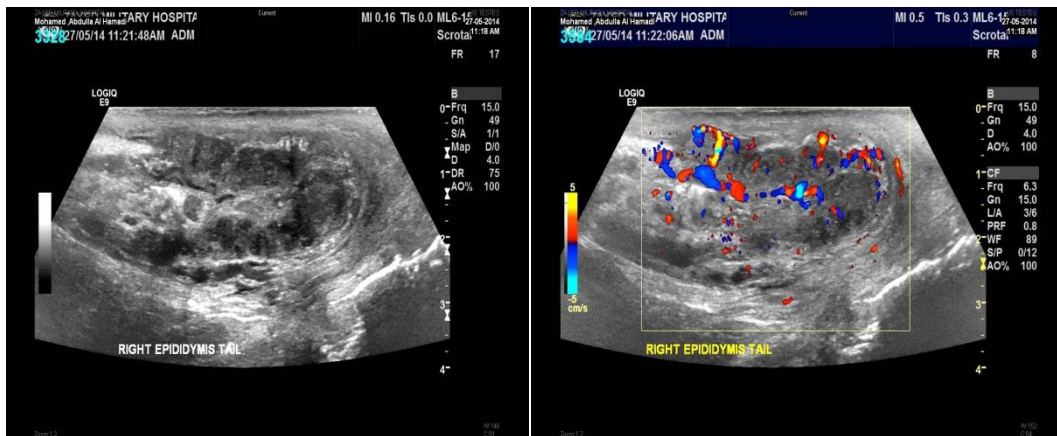


Image (6): shows enlargement with heterogeneous echo texture and increase in vascularization of the tail of the right epididymis ..

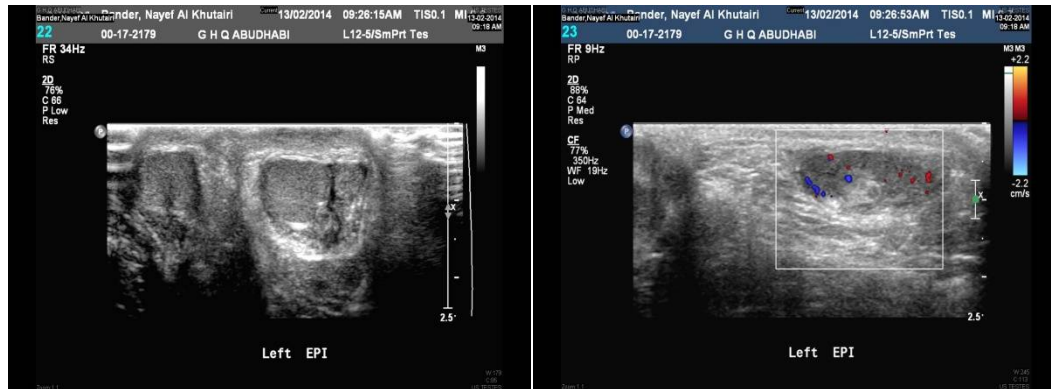


Image (7): shows enlarged of the left epididimis with no significant increase vascularization..

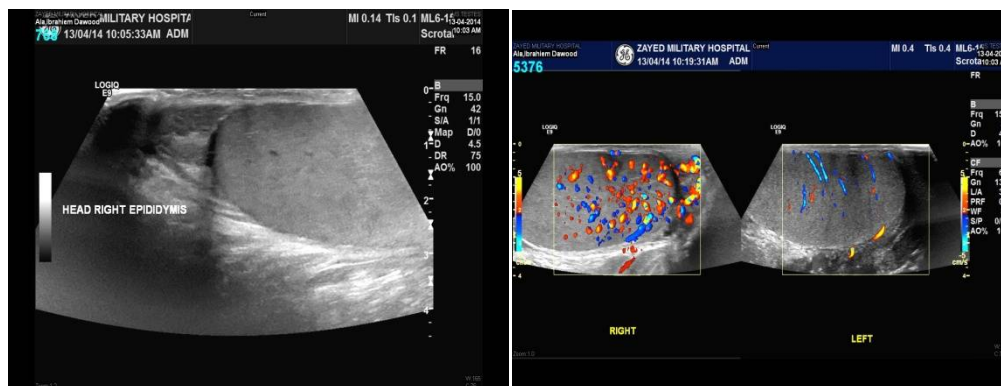


Image (8): shows heterogeneous echo texture with marked increase in vascularization in the head of the right epididimis .

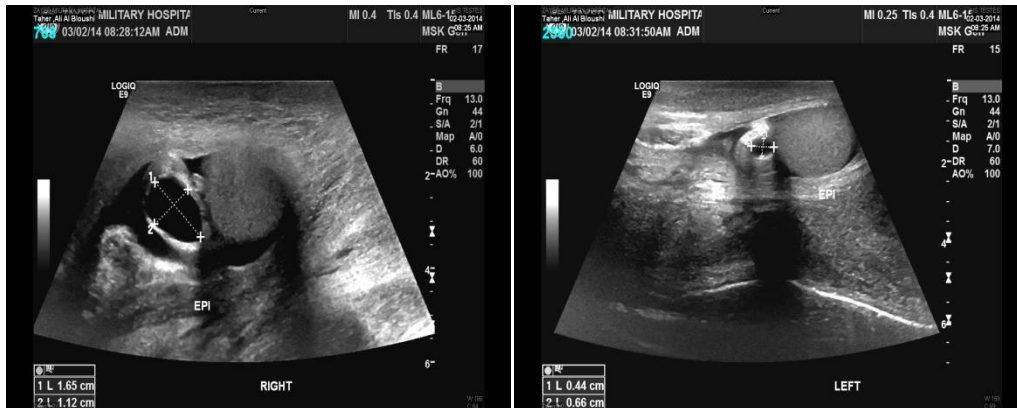


Image (9): shows 1.6×1 cm well demarcated anechic cyst in head of right epididmis ,there is 0.4×0.7 cm well demarcated anechoic cyst in head of left epididmis ,there is a mild hetrogenous hydrocele in the left side .

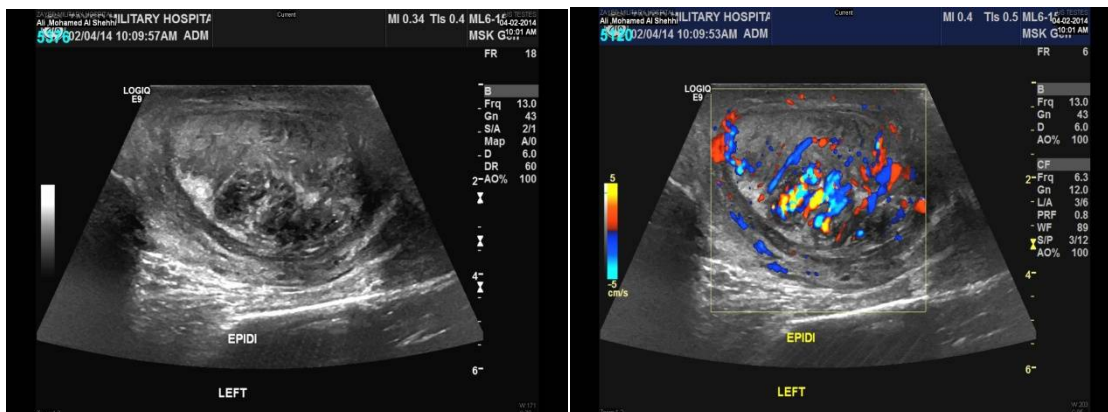


Image (10): shows enlargement with heterogeneous echo texture of the epididimis with increase in vascularization,.

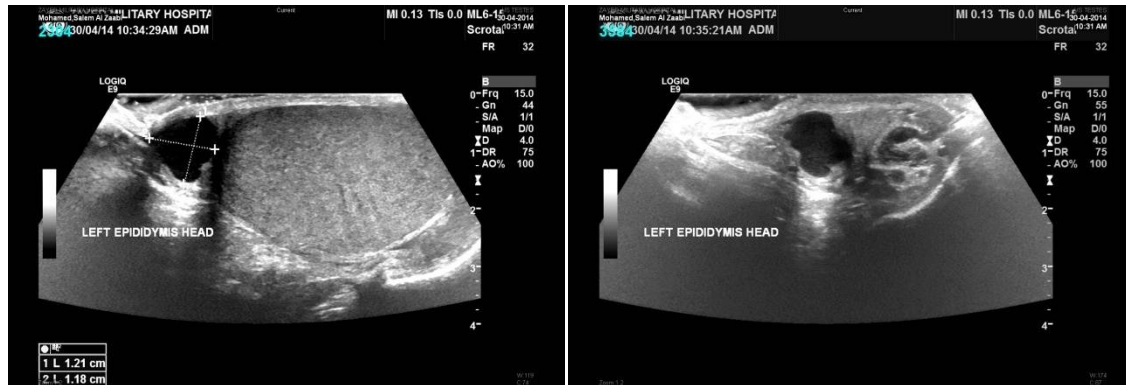


Image (11): shows benign simple cyst in the head of the left epididymis measuring 1.2×1.2 cm lobulated the rest of left epididymis is intact with the foci .

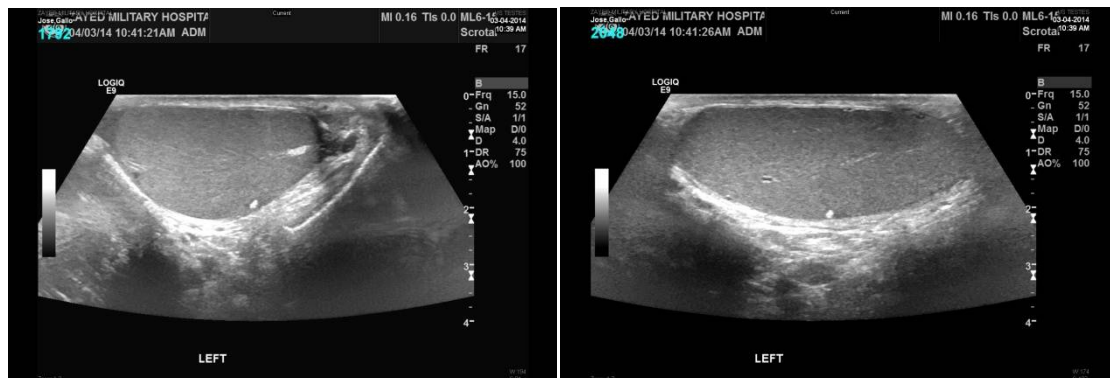


Image (12): shows Left microlithiasis noted line epididymis is unremarkable .



Image (13): shows Both testes and both epididymis are unremarkable .moderate thickened of scrotal wall noted.

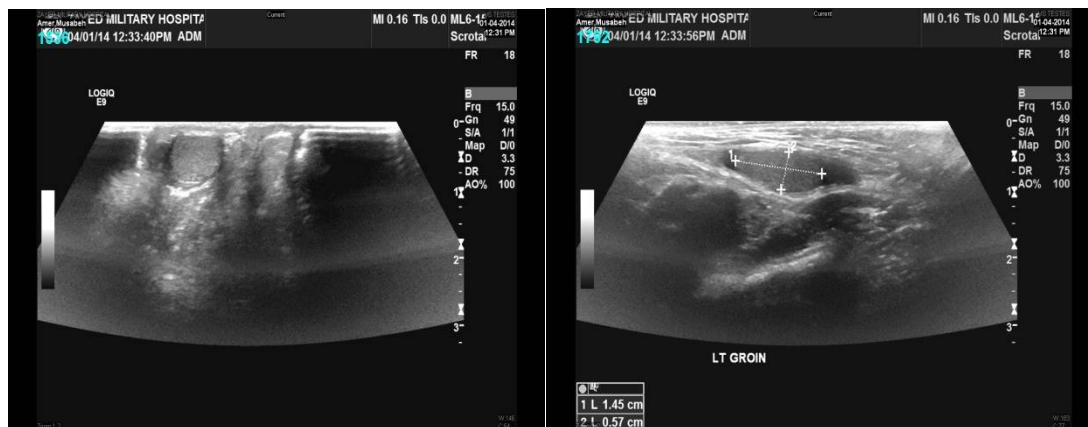


Image (14): shows ectopic ,undesend left testicle which is located above the left mid inguinal ligament at the left lower abdomen and measuring 1.45×0.57 cm .the right testicular appear normal .

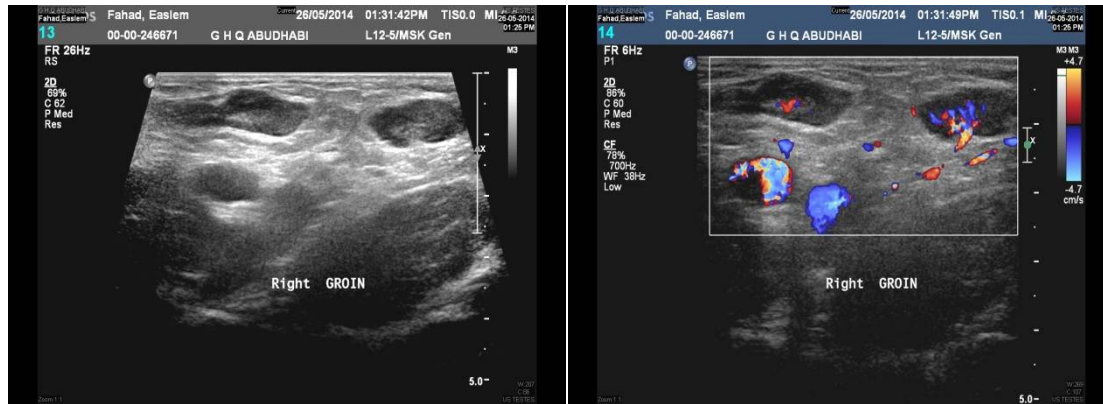


Image (15): shows Small lymph nodes seen in the right inguinal region which show centered hilum with slight increase in vascularization .