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Role of Colour Doppler Imaging and Sonographic Appearances in Diagnosis of Scrotal Disorder

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ABSTRACT

Background: Scrotal disorders, including inflammatory, vascular, neoplastic, and traumatic conditions, can significantly affect male reproductive health, presenting with symptoms such as pain, swelling, or masses. Accurate diagnosis is essential, and imaging techniques like ultrasonography (US) and Color Doppler Imaging (CDI) have become critical tools due to their non-invasive nature and high sensitivity. Grayscale US provides detailed anatomical views, especially for testicular tumors and hydroceles, while CDI assesses blood flow, aiding in the diagnosis of conditions like testicular torsion, epididymal-orchitis, and varicoceles. CDI also plays a vital role in evaluating scrotal trauma and testicular viability. ***Aim of the study:*** This study aims to explore the effectiveness of CDI in conjunction with grayscale ultrasonography in diagnosing various scrotal disorders. ***Methods:*** This prospective observational study was conducted over 12 months at the Department of Radiology and Imaging, BSMMU, Dhaka, Bangladesh from July 2023 to August 2024 including 85 male patients with scrotal pain, swelling, or masses. Grayscale ultrasonography and Color Doppler Imaging (CDI) were used to evaluate scrotal abnormalities, vascularity, and blood flow. Ethical approval and informed consent were obtained. Based on imaging criteria, patients were assessed for hydrocele, epididymal cysts, spermatoceles, varicocele, and testicular cysts. Exclusion criteria included prior surgery, incomplete imaging, and unwillingness to participate. Data were analyzed using SPSS (version 26.0), with results recorded in a structured proforma for analysis. ***Results:*** The study on 85 Bangladeshi patients with scrotal disorders found that the majority (52.9%) were aged 20-40 years. Common symptoms include pain and swelling (35.3%), with some cases involving fever (11.8%). The most frequent conditions were hydrocele (29.4%), varicocele (16.5%), and inflammatory conditions (44.7%), mainly acute and chronic epididymitis and epididymal-orchitis. Bilateral pathology was observed in 35.3% of cases. Non-inflammatory disorders like hydrocele and varicocele were more common (60%), while inflammatory conditions, including acute epididymitis and Fournier's gangrene, accounted for 44.7% of the cases. ***Conclusion:*** The study concludes that scrotal pathologies in Bangladeshi patients are diverse, with hydrocele, varicocele, and inflammatory conditions being the most common. CDI and sonography are practical diagnostic tools for accurately identifying these conditions and guiding appropriate treatment.

Keywords: Colour Doppler Imaging (CDI), Sonographic Appearances and Scrotal Disorder.

INTRODUCTION

Scrotal disorders encompass a wide range of conditions, including inflammatory diseases, vascular abnormalities, neoplastic processes, and traumatic injuries. These disorders can significantly impact male reproductive health and may present with pain, swelling, or palpable masses, necessitating accurate and timely diagnosis [1]. Imaging

techniques, particularly ultrasonography (US) and Color Doppler Imaging (CDI) have emerged as essential diagnostic tools for evaluating scrotal pathologies, given their non-invasive nature, cost-effectiveness, and high sensitivity [2]. Conventional grayscale ultrasonography provides excellent anatomic details of the scrotum, allowing differentiation between intratesticular and extratesticular lesions. It is particularly effective in detecting testicular tumors, hydroceles, and scrotal wall abnormalities [3]. However, grayscale imaging alone has limitations in assessing vascular integrity and differentiating between ischemic and inflammatory conditions. This is where CDI plays a crucial role. By evaluating blood flow dynamics in the scrotum, CDI enables the identification of testicular torsion, epididymal-orchitis, and varicocele with greater accuracy [4]. Among acute scrotal disorders, testicular torsion and epididymal-orchitis are the most commonly encountered conditions requiring rapid differentiation due to their differing management strategies. Testicular torsion, a surgical emergency, presents as a twisting of the spermatic cord, leading to compromised blood supply and potential testicular infarction. CDI reveals an absence or reduction of blood flow in the affected testis, confirming the diagnosis [5]. Conversely, epididymal-orchitis, an inflammatory condition usually of infectious origin, shows increased vascularity on CDI, distinguishing it from torsion [6]. Vascular pathologies such as varicoceles, a common cause of male infertility, can also be effectively evaluated using CDI. Varicoceles result from incompetent venous drainage of the pampiniform plexus, leading to venous dilatation and reflux. CDI demonstrates venous distension and abnormal retrograde flow, aiding diagnosis and grading [7]. Additionally, scrotal trauma cases benefit from CDI in assessing testicular viability and detecting testicular rupture or hematomas [8]. Integrating sonographic appearances with CDI findings enhances diagnostic precision, reduces unnecessary surgical explorations, and improves patient outcomes. This study aims to explore the effectiveness of CDI in conjunction with grayscale ultrasonography in diagnosing various scrotal disorders.

METHODOLOGY & MATERIALS

This study was designed as a prospective observational study conducted at the Department of Radiology and Imaging, BSMMU, Dhaka, Bangladesh from July 2023 to August 2024. Patients with scrotal pain, swelling, palpable masses, or other scrotal abnormalities were evaluated using grayscale ultrasonography (US) and Color Doppler Imaging (CDI). Ethical clearance was obtained from the institutional ethics committee, and written informed consent was secured from all participants. The study included 85 male patients who presented with symptoms indicative of scrotal pathology. Patients with a history of prior scrotal surgery, incomplete imaging studies, or unwilling participation were excluded.

Imaging Protocol

All patients underwent grayscale ultrasonography followed by Color Doppler Imaging using a [Ultrasound Machine Model, e.g., GE Logiq E9] equipped with a high-frequency (7–15 MHz) linear transducer. The examination was performed in a warm room to avoid cremasteric reflex interference, and patients were scanned in the supine position with the scrotum supported.

Grayscale Ultrasonography

Grayscale ultrasonography was utilized to evaluate testicular echotexture and size, determining whether it was homogeneous or heterogeneous. Additionally, it assessed the presence of masses, fluid collections, or calcifications and measured scrotal wall thickness. The examination also included evaluating extra-testicular structures such as the epididymis, spermatic cord, and tunica layers.

Color Doppler Imaging (CDI)

Color Doppler Imaging (CDI) was performed to evaluate scrotal vascularity and detect blood flow abnormalities. The assessment included arterial and venous blood flow in the testes and epididymis, comparing intra-testicular blood flow between symptomatic and asymptomatic testes. Additionally, CDI helped identify hypervascularity, which may indicate infection or inflammation, and detect absent or reduced blood flow, suggestive of ischemia or torsion. Venous reflux was also assessed to aid in the diagnosis of varicocele.

Diagnostic Criteria

Patients were categorized based on imaging findings, with diagnostic criteria refined for accuracy. Hydrocele was identified by an anechoic fluid collection around the testis. Epididymal cysts and spermatoceles were distinguished

based on their location and internal composition, with spermatoceles containing echogenic debris due to their sperm content. Varicocele was diagnosed by dilated pampiniform venous plexus with venous reflux on colour Doppler imaging. Testicular cysts were characterized as well-defined, anechoic lesions within the testicular parenchyma, lacking internal vascularity.

Data Analysis

Demographic data, clinical presentation, and imaging findings were recorded in a structured proforma. Data were analyzed using SPSS (version 26.0).

RESULTS

The study on 85 Bangladeshi patients diagnosed with scrotal disorders reveals a diverse spectrum of findings. The majority of patients (52.9%) were in the 20-40 years age group, with a smaller proportion under 20 years (17.6%) and over 40 years (29.4%) (Table 1). Clinical symptoms primarily included pain and scrotal swelling (35.3%), followed by pain, swelling, and fever (11.8%), indicating various scrotal conditions (Table 2). The most common pathologies observed were hydrocele (29.4%), varicocele (16.5%), and inflammatory conditions (44.7%), with acute and chronic epididymitis and epididymal-orchitis being the most frequent inflammatory diagnoses (Table 5). A notable portion of cases involved bilateral pathology (35.3%), reflecting the involvement of both sides in conditions like varicocele and hydrocele. Non-inflammatory disorders such as hydrocele and varicocele were more prevalent (60%), whereas inflammatory conditions, including acute epididymitis and Fournier's gangrene, represented 44.7% of cases (Table 6).

Table 1: Age Distribution of Patients

Age Group	Frequency (n)	Percentage (%)
<20 years	15	17.65
20-40 years	45	52.94
>40 years	25	29.41
Total	**85**	**100.00**

Table 2: Distribution of Symptoms

Symptoms	Frequency (n)	Percentage (%)
Pain and Scrotal Swelling	30	35.29
Pain, Swelling and Fever	10	11.76
Scrotal Swelling	12	14.12
Pain in scrotum	8	9.41
Infertility	7	8.24
Absent testis on palpation	4	4.71
Trauma	5	5.88
Dysuria	3	3.53
Pain abdomen	3	3.53
Erythematous scrotum	3	3.53
Total	**85**	**100.00**

Table 3: Spectrum of Pathologies

Spectrum of Pathologies	Frequency (n)	Percentage (%)
Hydrocele	25	29.41
Inflammatory	12	14.12
Varicocele	14	16.47
Undescended testis	5	5.88
Epididymal cyst	6	7.06
Hernia	4	4.71
Scrotal tumours	4	4.71

Torsion testis	4	4.71
Spermatocele	3	3.53
Others	5	5.88
Normal	3	3.53
Total	**85**	**100.00**

Table 4: Laterality of Pathology

Side	Frequency (n)	Percentage (%)
Bilateral	30	35.29
Right	25	29.41
Left	30	35.29
Total	**85**	**100.00**

Table 5: Distribution of Inflammatory Conditions

Pathology	Frequency (n)	Percentage (%)
Acute Epididymitis	6	7.06
Acute Epididymo-Orchitis	5	5.88
Acute Orchitis	3	3.53
Chronic Epididymitis	4	4.71
Chronic Epididymo-Orchitis	5	5.88
Scrotal Wall Inflammation	4	4.71
Scrotal Filariasis	3	3.53
Funiculitis	3	3.53
Tubercular Epididymo-Orchitis	3	3.53
Fournier's Gangrene	2	2.35
Total	**38**	**44.71**

Table 6: Distribution of Non-Inflammatory Pathologies

Pathology	Frequency (n)	Percentage (%)
Hydrocele	25	29.41
Epididymal Cyst	6	7.06
Spermatocele	3	3.53
Varicocele	14	16.47
Testicular Cyst	3	3.53
Total	**51**	**60.00**

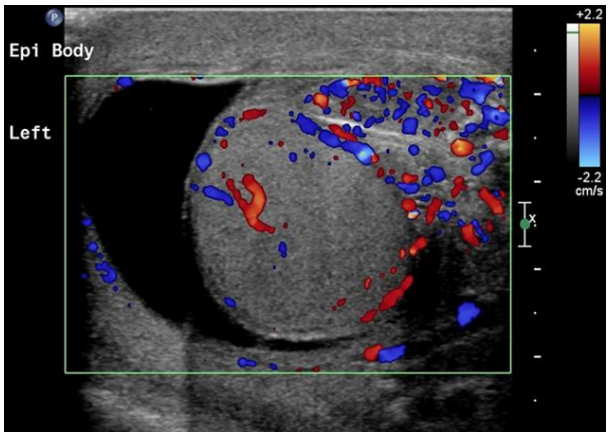

Figure 1: Acute Epididymo-Orchitis

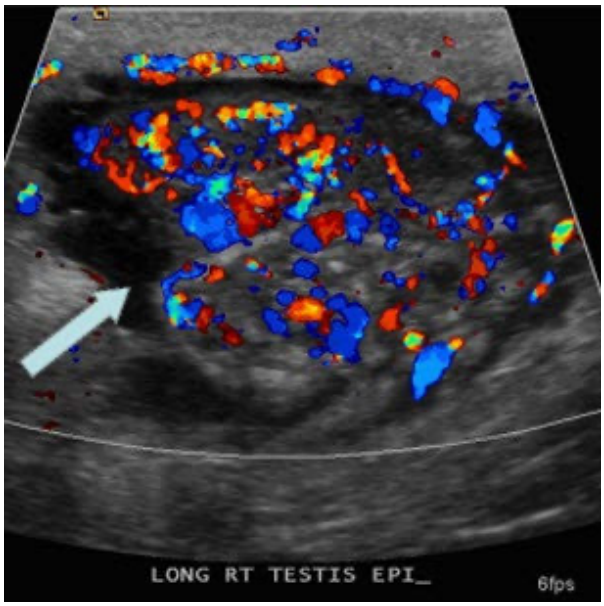

Figure 2: Chronic Epididymo-Orchitis

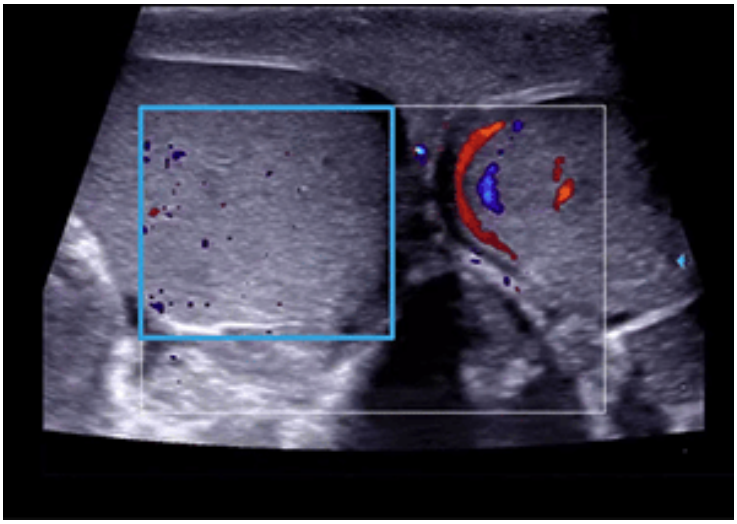

Figure 3: Scrotal Filariasis

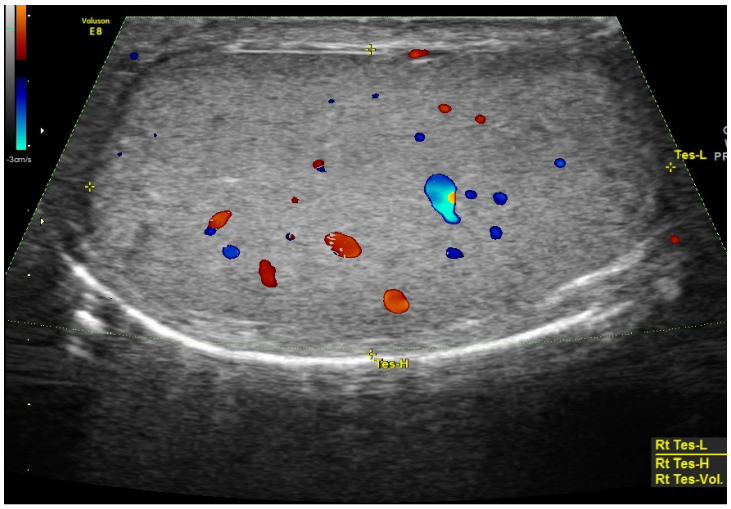

Figure 4: Hydrocele

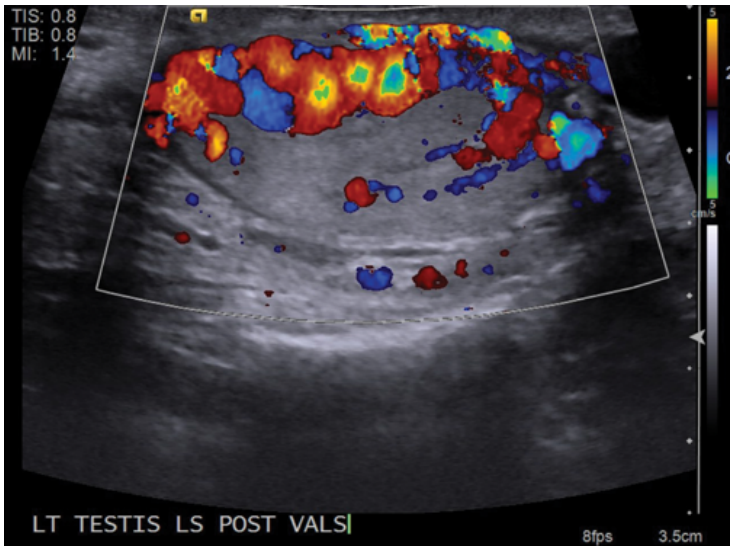

Figure 5: Varicocele

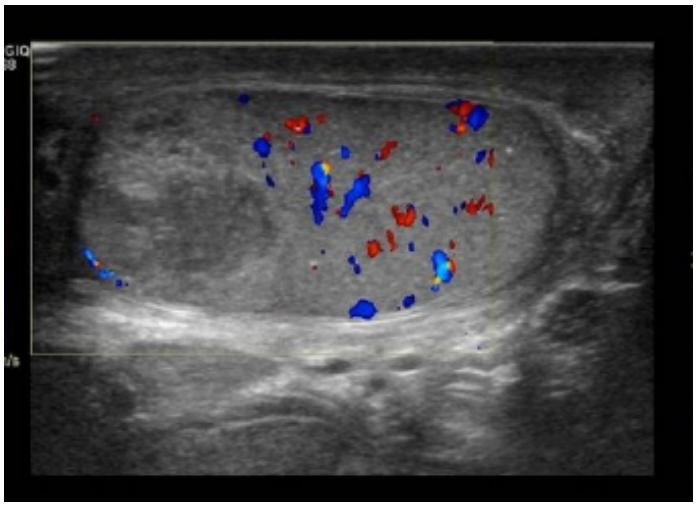

Figure 6: Neoplastic Testicular Swellings

DISCUSSION

The study findings reveal a broad spectrum of scrotal pathologies, with hydrocele and varicocele being the most prevalent, followed by inflammatory conditions such as epididymitis and epididymal. This diverse presentation highlights the importance of imaging techniques in detecting and accurately diagnosing scrotal disorders. The majority of patients were between the ages of 20 and 40 years, which is consistent with previous studies reporting that scrotal conditions like varicocele and hydrocele predominantly affect men in their reproductive years [9]. In contrast, the relatively high percentage of patients over 40 years old (29.4%) suggests that scrotal disorders, including testicular cysts and varicocele, are not limited to younger individuals and may increase with age [10]. Symptomatically, pain and scrotal swelling were the most common presenting complaints, aligning with the findings of other studies that show these symptoms are frequently linked with a variety of scrotal pathologies, including hydrocele, varicocele, and epididymitis [11]. The relatively high frequency of pain, swelling, and fever (11.8%) suggests that infectious or inflammatory conditions like epididymitis and orchitis are common in this population. Systemic symptoms like fever often accompany these conditions and are usually caused by bacterial infections, making timely diagnosis crucial for effective management [12]. Regarding pathological findings, hydrocele was the most frequently observed condition, affecting 29.4% of patients. Hydrocele is characterized by an accumulation of fluid in the scrotum and is typically benign, although it can cause discomfort and enlargement of the scrotal sac [13]. Varicocele was the second most common pathology, affecting 16.5% of patients. This condition is often asymptomatic but can lead to infertility and testicular atrophy if left untreated [14]. The association between varicocele and infertility is well documented, and CDI remains the gold standard for

diagnosis, allowing for the assessment of venous reflux and the identification of dilated veins [6]. Inflammatory conditions, such as acute and chronic epididymitis and epididymal-orchitis, were identified in 44.7% of cases, highlighting the significant burden of infectious scrotal disorders. These conditions are typically caused by bacterial infections, most commonly from sexually transmitted pathogens or urinary tract infections (UTIs). They can lead to complications such as abscess formation or infertility if not promptly treated [11]. Fournier's gangrene, a rare but severe necrotizing soft tissue infection, was also observed in two patients, underscoring the importance of early identification and aggressive treatment in preventing mortality [15]. The findings of this study underscore the utility of CDI and sonography in the non-invasive evaluation of scrotal disorders. Colour Doppler Imaging provides crucial blood flow information, helping differentiate between conditions like varicocele, torsion, and epididymitis, which may present with similar symptoms [16]. Assessing blood flow dynamics is invaluable in distinguishing between benign conditions like hydrocele and more serious conditions like torsion, which require urgent intervention to prevent testicular loss.

CONCLUSION

In conclusion, the study highlights the diverse range of scrotal pathologies observed in Bangladeshi patients, with hydrocele, varicocele, and inflammatory conditions being the most prevalent. CDI and sonography provide a comprehensive diagnostic approach, accurately identifying these conditions and guiding appropriate management. Future research should focus on the long-term outcomes of these conditions in Bangladeshi men and the role of imaging in monitoring treatment efficacy.

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Ethical approval: *The study was approved by the Institutional Ethics Committee.*

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