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***Original Research Article***

# ROLE OF ULTRASONOGRAPHY WITH COLOR DOPPLER IN THE EVALUATION OF ACUTE SCROTAL PAIN AT A TERTIARY CARE CENTRE IN EASTERN NEPAL

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## ABSTRACT

**Background**
Acute scrotal pain is a common urological emergency requiring prompt assessment to prevent testicular loss. Etiologies include surgical conditions such as testicular torsion and medical conditions like epididymo-orchitis. Clinical differentiation is often challenging, and delayed or misdiagnosis can lead to irreversible testicular damage. Ultrasonography with color Doppler plays a key role by evaluating both the morphology and vascularity of the testicle.

**Objectives**
To determine the diagnostic role of ultrasonography with color Doppler in the evaluation of acute scrotal pain and to identify its etiological spectrum in Eastern Nepal.

**Methods**
A prospective observational study was conducted among 118 male patients with acute scrotum pain of less than 72 hours' duration, recruited from the emergency department of B & C Medical College Teaching Hospital and Research Center. Patients underwent grey-scale and color Doppler ultrasonography, and findings were correlated with surgical or clinical outcomes. Data was analyzed using IBM 'SPSS' Statistics v.27. Continuous variables were presented as mean ± SD, and categorical variables were analyzed by the Chi-square test. A p-value < 0.05 was considered to be significant.

**Results**
The mean age was 22.97 ± 6.87 years, and the mean duration of symptoms was 18.54 ± 10.01 hours. The most common etiologies were epididymitis (33.1%), epididymo-orchitis (20.3%), and testicular torsion (15.3%). Increased flow (61.0%) and absent/reduced flow (15.3%) were the predominant Doppler patterns.

**Conclusions**
Color Doppler ultrasonography is a rapid, non-invasive, and highly reliable diagnostic tool for differentiating testicular torsion from inflammatory causes, thereby improving management outcomes and testicular salvage rates in acute scrotal pain.

**Keywords:** *Acute Scrotum, Doppler, Epididymo-Orchitis, Testicular Torsion, Ultrasonography*



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## INTRODUCTION

Acute scrotal pain (ASP) is a urological emergency requiring urgent diagnosis and management to prevent irreversible testicular injury. It may occur due to various causes, but most commonly due to testicular torsion, epididymo-orchitis, trauma, or torsion of testicular appendages. Among these, testicular torsion is the most time-sensitive condition, with irreversible ischemic injury typically occurring within 6-12 hours of symptom onset if not promptly treated [1-2]. The overlapping clinical features of scrotal pathologies-including swelling, tenderness, and erythema-make diagnosis challenging even for experienced clinicians. In adolescents and young adults, torsion accounts for nearly 25% of all acute scrotal presentations, whereas the infectious causes predominate in older populations [3-4].

Management of ASP depends on the etiology. Testicular torsion requires prompt surgical exploration and detorsion to restore perfusion and testicular viability. Epididymo-orchitis and other infectious causes are treated with appropriate antibiotics and supportive measures, such as scrotal elevation, adequate analgesics, and hydration [5,6]. Conservative management is suitable for minor traumatic or inflammatory cases, but clinical vigilance is important to avoid further complications. The cornerstone of successful treatment is the ability to accurately and rapidly distinguish surgical from medical causes, highlighting the central role of diagnostic imaging in the emergency context [7-8].

Ultrasonography (USG) with color Doppler imaging has become the gold standard for evaluation of ASP because of its non-invasive ability to assess the testicular morphology and perfusion in real-time. Grey-scale imaging identifies structural abnormalities such as hydrocele, hematoma, or abscess formation, whereas color doppler assesses testicular blood flow that can differentiate torsion (absent or decreased) from inflammatory causes (increased) of scrotal pain [9-10]. Several studies have been conducted to demonstrate the diagnostic accuracy of color doppler ultrasound in differentiating torsion from epididymo-orchitis, with reported sensitivities and specificities above 90% in high resource settings [1,9].

In Eastern Nepal, diagnosing acute scrotal pain in emergency departments remains challenging because of limited ultrasound access round the clock at all the centers, and delayed patient presentation. Misdiagnosis rates for torsion may be as high as 30-50%, with testicular loss approaching 100% after 24 hours. Furthermore, over 40% of patients present to emergency department after 12 hours due to cultural stigma and geographical barriers, with a further decline in salvage rates [4,16].

This study aimed to determine the diagnostic role of ultrasonography with color Doppler in the evaluation of acute scrotal pain and to identify its etiological spectrum in Eastern Nepal.

## METHODS

This prospective observational study was conducted at B&C Medical College Teaching Hospital and Research Center, Birtamode, Jhapa, Nepal in collaboration with the Departments of Radiology, Urology, General Surgery and Emergency Medicine from May 2025 till January 2026. The study aimed to assess the diagnostic accuracy of ultrasonography with color Doppler in distinguishing testicular torsion from other causes of acute scrotal pain, particularly epididymo-orchitis, in patients presenting to the emergency department.

A sample size of 118 was estimated using 95% confidence level, a 7% margin of error, and an expected prevalence of testicular torsion of 18.3 percent based on a previous study by Salahuddin (2017) [11]. All 118 male patients aged 12 years and above presenting with acute scrotal pain of less than 72 hours duration were recruited consecutively during the study period. The age cutoff of 12 years was chosen because testicular torsion peaks in adolescence, and consent could be obtained from both patients and guardians as per institutional policy.

Exclusion Criteria:

- Chronic scrotal pain of more than 72 hours
- Previous scrotal surgery
- Scrotal trauma (as primary presenting complaint)
- Known scrotal masses or testicular tumors
- Clear alternative diagnoses (e.g., incarcerated hernia)
- Hemodynamically unstable requiring immediate resuscitation

Ethical approval for the study was obtained from the Institutional Review Committee of B&C Medical College Teaching Hospital and Research Center, Birtamod (Reference No.00332025). The study site was chosen because it has a diverse patient population from rural and urban areas, it has 24-hour radiology and urology services, and it has an adequate infrastructure for diagnosis including color Doppler ultrasonography and trained radiologists who could interpret the images on the spot. Throughout the study, an effort was made to ensure consistency in the imaging interpretation process by using a single radiologist or consensus reading to reduce the inter-observer variability.

Upon presentation to the emergency room, all potentially eligible patients were first screened by the attending clinician. After patients met the inclusion criteria, informed written consent was obtained from each participant or their legal guardian (for minors aged 12-17 years). A detailed clinical history was recorded including the onset, duration, character, and radiation of pain, associated symptoms like swelling, nausea, vomiting, fever, urinary complaints, and any preceding trauma or infection. A focused physical examination of the scrotum was performed to evaluate tenderness, swelling, erythema, position of the testis, and cremasteric reflex.

Following clinical assessment, each patient underwent ultrasonography with a color Doppler imaging study that was performed by a qualified radiologist using a high frequency linear transducer. The grey scale ultrasonography assessed testicular size, echotexture present hydrocele, epididymal enlargement or any associated fluid collections. Color Doppler imaging was then used to determine intra-testicular and peri-testicular blood flow patterns, spectral waveforms, and vascular symmetry between both testes. Absence or significant decreased blood flow was suggestive of testicular torsion and increased flow, especially in the epididymal region, was suggestive of epididymo-orchitis. Other findings such as reactive hydrocele, scrotal wall edema or torsion of testicular appendages were documented as secondary findings.

All of the patients diagnosed with suspected testicular torsion on color Doppler ultrasonography were referred to the Urology Department for urgent surgical exploration and final diagnosis. Cases presenting with epididymo-orchitis or other conditions other than surgical treatment were managed conservatively under urology department. The final diagnosis was made on the basis of the surgical findings (for torsion cases) or clinical course and treatment response (for non-torsion cases).

Data were analyzed by using the IBM Statistics version 27 (IBM Corp., Armonk, NY, USA). Continuous variables like age and duration of symptoms were presented as mean ± standard deviation (SD). Categorical variables, such as side of involvement (bilateral, right or left) and final diagnosis (torsion, epididymo-orchitis, torsion of appendage, others) were expressed as frequencies and percentages. Data were stratified by age, duration of symptoms and side of involvement to account for effect modifiers. Post-stratification, Chi-square test was used and P-value < 0.05 was considered statistically significant.

## RESULTS

**Table 1: Frequency distribution of different variables (n=118)**

| | Variables | Frequency | Percent |
|---|---|---|---|
| Age groups | ≤30 years | 101 | 85.6 |
| | >30 years | 17 | 14.4 |
| | Mean age (years) | 22.976.87± | |
| Duration of symptoms | ≤24 hours | 89 | 75.4 |
| | >24 hours | 29 | 24.6 |
| | Mean duration (hours) | 18.5410.01± | |
| Side of involvement | Right | 62 | 52.5 |
| | Left | 54 | 45.8 |
| | Bilateral | 2 | 1.7 |
| Final diagnosis | Normal | 6 | 5.1 |
| | Epididymitis | 39 | 33.1 |
| | Epididymo-orchitis | 24 | 20.3 |
| | Orchitis | 9 | 7.6 |
| | Testicular abscess | 3 | 2.5 |
| | Testicular torsion | 18 | 15.3 |
| | Scrotal trauma | 9 | 7.6 |
| | Testicular trauma | 3 | 2.5 |
| | Hernia | 7 | 5.9 |
| Color doppler findings | Increased flow | 72 | 61.0 |
| | Absent or reduced flow | 18 | 15.3 |
| | Peristaltic bowel loops in scrotum | 7 | 5.9 |
| | Irregular echo-texture or hematoma | 9 | 7.6 |
| | Heterogeneous echo-texture with variable flow | 6 | 5.1 |
| | Normal flow pattern | 6 | 5.1 |

**Table 1**: presents the demographic and clinical characteristics of 118 patients who presented with acute scrotal pain and were evaluated using ultrasonography with color Doppler. The majority of patients (85.6%) were aged 30 years or below, while only 14.4% were above 30 years. The mean age of the study population was 22.97 ± 6.87 years. Regarding symptom duration, most patients (75.4%) presented within 24 hours of onset, whereas 24.6% presented after 24 hours. The mean duration of symptoms was 18.54 ± 10.01 hours. With respect to the side of involvement, the right testis was slightly more affected (52.5%) than the left (45.8%), while bilateral involvement was rare (1.7%).

Regarding the final diagnosis, 33.1% of cases were diagnosed as epididymitis, followed by epididymo-orchitis (20.3%) and testicular torsion (15.3%). Other less frequent etiologies were orchitis (7.6%), scrotal trauma (7.6%), hernia (5.9%), normal findings (5.1%), testicular abscess (2.5%) and testicular tumor (2.5%). These results show that inflammatory causes are the predominant etiology, but torsion remains an important and time-sensitive differential diagnosis. In terms of color Doppler ultrasonography findings, increased flow was the most common pattern found (61.0%), consistent with inflammatory conditions such as epididymitis and epididymo-orchitis. Absent

or decreased flow was observed in 15.3%, strongly suggestive of testicular torsion. Other findings included peristaltic bowel loops in the scrotum (5.9%), suggestive of hernia; irregular echotexture or hematoma (7.6%), related to trauma; heterogeneous echotexture with variable flow (5.1%), typical of testicular tumors or of abscesses; and normal flow pattern (5.1%).

**Table 2: Stratification of final diagnosis with respect to different variables**

| Variables | | Final Diagnosis | | | | | | | | | p-value |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Normal | Epididymitis | Epididymo-orchitis | Orchitis | Testicular abscess | Testicular torsion | Scrotal trauma | Testicular trauma | Hernia | |
| Age groups | ≤ 30 years | 6 | 33 | 20 | 7 | 3 | 16 | 9 | 2 | 5 | 0.673 |
| | | 5.9% | 32.7% | 19.8% | 6.9% | 3.0% | 15.8% | 8.9% | 2.0% | 5.0% | |
| | > 30 years | 0 | 6 | 4 | 2 | 0 | 2 | 0 | 1 | 2 | |
| | | 0.0% | 35.3% | 23.5% | 11.8% | 0.0% | 11.8% | 0.0% | 5.9% | 11.8% | |
| Duration of symptoms | ≤ 24 hours | 4 | 27 | 17 | 7 | 3 | 16 | 7 | 1 | 7 | 0.320 |
| | | 4.5% | 30.3% | 19.1% | 7.9% | 3.4% | 18.0% | 7.9% | 1.1% | 7.9% | |
| | > 24 hours | 2 | 12 | 7 | 2 | 0 | 2 | 2 | 2 | 0 | |
| | | 6.9% | 41.4% | 24.1% | 6.9% | 0.0% | 6.9% | 6.9% | 6.9% | 0.0% | |
| Side involved | Right | 4 | 21 | 12 | 4 | 0 | 14 | 2 | 0 | 5 | 0.123 |
| | | 6.5% | 33.9% | 19.4% | 6.5% | 0.0% | 22.6% | 3.2% | 0.0% | 8.1% | |
| | Left | 2 | 17 | 12 | 4 | 3 | 4 | 7 | 3 | 2 | |
| | | 3.7% | 31.5% | 22.2% | 7.4% | 5.6% | 7.4% | 13.0% | 5.6% | 3.7% | |
| | Bilateral | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | |
| | | 0.0% | 50.0% | 0.0% | 50.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | |

**Table 2** presents the association between definitive diagnosis and important variables such as age group, duration of symptoms and side of involvement. Overall, no statistically significant associations were found. However, inflammatory causes predominated across all subgroups, while testicular torsion remained an important etiology among younger patients with early presentation.

## DISCUSSION

This prospective observational study evaluated the diagnostic role of ultrasonography with color Doppler in 118 patients presenting with acute scrotal pain at a tertiary care center in Eastern Nepal. The findings demonstrate that color Doppler ultrasonography is a rapid, non-invasive and reliable tool for distinguishing testicular torsion from inflammatory causes, thereby aligning with the study's primary objective.

The most common etiologies identified were epididymitis (33.1%), epididymo-orchitis (20.3%) and testicular torsion (15.3%), followed by orchitis (7.6%), scrotal trauma (7.6%) and hernia (5.9%). This distribution closely parallels findings from other studies across similar healthcare settings, where inflammatory causes are predominant and torsion accounts for 10-20% of acute scrotal presentations [12-14].

Hassan (2025) reported epididymo-orchitis in 38% of cases while torsion in 16% of acute scrotal presentations. Similarly, Haidar and Farooq (2025) reported epididymitis and torsion rates of 34% and 13%, respectively, confirming that inflammatory causes consistently outweigh vascular causes in both rural and urban populations [12,13]. The predominance of inflammatory etiologies on our cohort (53.4% combined for epididymitis and epididymo-orchitis) reflects the demographic profile, as infectious causes typically prevail in sexually active and older age groups [3,4].

The mean age in our study population was 22.97 ± 6.87 years, with 85.6% of patients aged 30 years or below. This age distribution is consistent with the known peak incidence of acute scrotal pathologies in young males. Schillirò (2025) noted that approximately 80% of torsion cases occur before age 25, with similar demographic trends observed across Asia and Europe [14]. The right-sided predominance (52.5%) observed in our study aligns with the findings of Mehta (2025), who reported 54% right-sided involvement, attributed to anatomical variation in spermatic cord length and testicular fixation [15].

Regarding symptom duration, the mean presentation time was 18.5410.01± hours, with 75.4% of the patients presenting within 24 hours of onset. This suggests comparatively better healthcare access than older regional data, although delayed presentation remains clinically significant. Artukovich (2022) highlighted that testicular salvage rates dropped drastically when presentation exceeds 24 hours, reinforcing the importance of early evaluation with Doppler in peripheral emergency settings [16].

The color Doppler ultrasonography findings aligned with expected diagnostic patterns. Increased vascular flow (61.0%) was seen predominantly in inflammatory conditions (e.g., epididymitis and epididymo-orchitis), while absent or diminished vascular flow (15.3%) was typical for torsion. Those results are comparable to those of Friedman (2019), who reported perfusion changes with 93% sensitivity and 97% specificity for differentiating torsion from infectious etiologies [17].

Furthermore, Zou (2025) emphasized that absent intratesticular flow remains the most reliable indicator of torsion, even in equivocal clinical presentations [18]. Heterogeneous echotexture with variable flow

(5.1%) was noted in cases corresponding to abscesses or testicular tumors, a finding also described by Di Serafino (2021), who stressed the complementary role of gray-scale imaging in identifying complex scrotal pathologies [19]. Similarly, peristaltic bowel loops within the scrotum (5.9%) correctly identified hernias, while irregular echotexture or hematoma (7.6%) correlated with traumatic etiologies.

No statistically significant association was found between final diagnosis and age group, symptom duration, or side involved ($p > 0.05$ for all comparisons). This finding is consistent with Sevdimbaş (2023), who demonstrated that demographic factors are not strong independent predictors of etiology once Doppler findings are taken into consideration [20]. Nevertheless, descriptive patterns in our cohort revealed that testicular torsion remained an important diagnosis among younger patients (15.8% in ≤30 years vs. 11.8% in >30 years) and those presenting within 24 hours (18.0% vs. 6.9% in delayed presenters), underscoring the need for high clinical suspicion in these subgroups.

The diagnostic yield of color Doppler ultrasonography in our study supports its role as the non-invasive gold standard for evaluating acute scrotal pain. Louviere (2025) also found that doppler accurately determined the etiology in 94% of acute scrotal cases, suggesting that it is accurate and reliable [21]. The high concordance between our findings and international studies validates the generalizability of color Doppler as a first-line diagnostic tool, even in resource-limited settings such as Eastern Nepal.

In Eastern Nepal, where geographical barriers and limited round-the-clock ultrasound access historically challenged prompt diagnosis, our findings demonstrate that color Doppler ultrasonography can effectively bridge this gap. Its routine use in emergency department protocols may significantly reduce unnecessary surgical exploration and improve testicular salvage rates in torsion cases. These results support the need for national diagnostic guidelines incorporating Doppler ultrasound and advocating for training programs to enhance radiologists' availability at district level hospitals. This study has several strengths. First, it provides prospective data from a tertiary care center in Eastern Nepal, a region with limited published literature on acute scrotal pain. Second, the use of a single experienced radiologist minimized inter-observer variability. Third, the correlation of ultrasound findings with surgical or clinical outcomes ensured diagnostic accuracy. Fourth, the inclusion of all consecutive patients during the study period reduced selection bias.

Despite these strengths, this study had some limitations. It was conducted at a single tertiary care center with a modest sample size (n = 118), which may impact the generalizability of findings to primary healthcare settings or different geographical regions. Second, the lack of long-term follow-up precluded evaluation of testicular viability or recurrence. Moreover, ultrasonography being operator-dependent, inter-observer variability could affect diagnostic consistency, though being minimized in this study by the involvement of a single experienced radiologist. The absence of contrast-enhanced ultrasonography (CEUS) or advanced Doppler techniques may have limited the detection of partial or intermittent torsion. Future multicentric studies with larger samples and assessment of functional outcome evaluation are recommended to strengthen evidence for establishing national guidelines.

## CONCLUSIONS

Color Doppler ultrasonography is a rapid, non-invasive, and highly reliable diagnostic modality for differentiating testicular torsion from inflammatory causes of acute scrotal pain, and its routine use in emergency departments can reduce unnecessary surgeries and improve testicular salvage rates, particularly in resource-limited setting in Eastern Nepal.

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