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Development of a diagnostic and management protocol for acute scrotum in a tertiary care hospital: A prospective observational study.

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Abstract

Background:
Acute scrotum is a urological emergency requiring timely evaluation to prevent testicular loss, particularly in cases of torsion. Differentiating torsion from inflammatory causes remains clinically challenging. This study aimed to develop and implement a structured diagnostic and management protocol for acute scrotum in a tertiary care setting.

Methods:
This prospective observational study was conducted at a tertiary care teaching hospital from August 2016 to October 2018. A total of 100 male patients presenting with acute scrotal pain, with or without swelling, were included. Clinical assessment, laboratory evaluation, and color Doppler ultrasonography were performed in all cases. Patients with findings suggestive of testicular torsion underwent emergency exploration, with orchidopexy performed for viable testes and orchidectomy for non-viable testes. Patients with inflammatory causes were managed conservatively. Follow-up was completed at 2 weeks and 1 month.

Results:
Of the 100 patients studied, testicular torsion (44%) and epididymo-orchitis (38%) were the most common etiologies, followed by acute hydrocele (7%), scrotal cellulitis/abscess (6%), and pyocele (3%). Color Doppler ultrasonography demonstrated high diagnostic reliability, particularly in differentiating torsion from inflammatory causes. Among the 44 torsion cases, 18 (41%) underwent orchidopexy and 26 (59%) underwent orchidectomy, with contralateral orchidopexy performed in all torsion patients. Conservatively managed patients showed significant clinical improvement, with 92% completing follow-up and reporting symptom resolution.

Conclusion:
The implementation of a structured clinical and diagnostic protocol enables timely diagnosis and appropriate management of acute scrotum, improving testicular salvage rates in torsion and ensuring effective conservative treatment in inflammatory conditions.

Recommendation:
Integration of standardized evaluation pathways and early referral protocols is strongly recommended to minimize diagnostic delays and prevent avoidable testicular loss.

Keywords: *Acute scrotum; Testicular torsion; Epididymo-orchitis; Doppler ultrasonography; Orchidopexy*
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Introduction
The acute scrotum represents a clinical syndrome characterized by sudden onset of scrotal pain, swelling, and tenderness, often demanding urgent evaluation and intervention. It is one of the most challenging emergencies faced in urology, as the underlying etiologies range from

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benign, self-limiting conditions to testicular torsion, a time-sensitive surgical emergency with profound implications for fertility and testicular viability [1]. Despite its relatively low overall incidence, the acute scrotum is of significant concern in both pediatric and adult populations because of the potential for testicular loss, psychological morbidity, and medicolegal consequences if timely diagnosis is missed [2]. The differential diagnosis of acute scrotum is wide, but in clinical practice, three entities predominate: testicular torsion, torsion of testicular appendages, and epididymo-orchitis [3]. Among these, testicular torsion warrants special emphasis. Salvage of the affected testis is critically dependent on the interval between symptom onset and surgical detorsion, with near-complete preservation possible within 6 hours but progressively diminishing thereafter, falling to less than 20% beyond 24 hours [4,5]. Conversely, inflammatory causes such as epididymo-orchitis, although more common in adults, can usually be managed conservatively with antibiotics and supportive therapy [6]. This dichotomy underscores the need for an accurate and efficient diagnostic protocol.

Clinical evaluation remains the first step, including a detailed history and focused physical examination assessing onset, severity of pain, systemic features, and specific signs such as the cremasteric reflex and Prehn's sign [7]. However, reliance on clinical signs alone has inherent limitations. Color Doppler ultrasonography has emerged as the most widely used adjunct in the evaluation of acute scrotum, with reported sensitivity and specificity exceeding 95% for inflammatory conditions, and specificity approaching 99% for torsion, though sensitivity may be lower [8]. Nevertheless, guidelines emphasize that imaging should not delay urgent surgical exploration when torsion is strongly suspected [9].

Epidemiological observations from tertiary care hospitals in India reveal that epididymo-orchitis is the leading cause of acute scrotum, whereas torsion, although less frequent, remains a crucial surgical emergency [10,11]. These findings highlight the variability in presentation across age groups and healthcare settings, and the need for context-specific protocols that integrate clinical, radiological, and surgical decision-making.

In this context, the development of a standardized diagnostic and management protocol for acute scrotum in tertiary care settings is imperative. Such a protocol would facilitate rapid triage, reduce diagnostic uncertainty, minimize testicular loss, and improve overall patient outcomes. The present study is aimed at formulating and validating such a protocol, thereby contributing to structured and evidence-based management of this urological emergency.

Materials and methods

study design

This was a prospective observational study conducted to develop and evaluate a standardized protocol for the diagnosis and management of acute scrotum in a tertiary care setting.

Study setting

The study was carried out in the Department of General Surgery at Acharya Vinoba Bhave Rural Hospital (AVBRH), Sawangi (Meghe), India, a tertiary care teaching hospital that provides emergency surgical services to both rural and semi-urban populations. The study period extended from August 2016 to October 2018.

Participants

All male patients presenting with acute onset scrotal pain, with or without swelling, were considered for inclusion.

Inclusion criteria:

- Acute scrotal pain of ≤14 days duration
- Age ≥ 5 years
- Willingness to provide informed consent

Exclusion criteria:

- Painless scrotal swellings
- Inguino-scrotal hernia
- Trauma-related scrotal injuries
- Isolated scrotal skin infections

During the study period, 132 patients presented with acute scrotal complaints. Of these, 32 patients were excluded based on the criteria above. The final study sample consisted of 100 patients. Of these, 92 patients completed follow-up.

Bias control measures

To reduce diagnostic bias, clinical examination and ultrasonography were performed independently by senior surgical and radiology residents under consultant supervision. Emergency exploration was prioritized in clinically suspected torsion to avoid delay-related outcome bias.

Study size justification

The sample size of 100 patients was determined based on the hospital's average annual caseload of acute scrotal

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emergencies, ensuring feasibility and representation within the study period.

Data collection

Data were collected using a structured case record form. Parameters recorded:

- Age, symptoms, pain duration, fever, urinary symptoms
- Physical findings (tenderness, testicular lie, swelling, cremasteric reflex)
- Laboratory tests: CBC, RBS, urine analysis

Color Doppler findings: vascularity pattern, whirlpool sign, epididymal involvement

- Patients with suspected torsion underwent emergency surgical exploration. Epididymo-orchitis and inflammatory causes were treated conservatively.

Statistical analysis

Data were analyzed using SPSS version 22.0. Descriptive statistics, including mean, proportions, frequencies, and percentages, were used. Findings were presented in tables and charts to illustrate distribution and management outcomes.

Ethical consideration

Ethical approval for this study was obtained from the Institutional Ethics Committee of AVBRH (Approval No.: *IEC/AVBRH/2016/AcuteScrotum/45*; Date: *12 August 2016*). Written informed consent was obtained from all participants or their guardians (in case of minors).

Result

A total of 132 patients presented to the emergency department with acute scrotal complaints during the study period. Of these, 32 patients were excluded due to painless swellings, inguino-scrotal hernia, isolated scrotal wall infections, or trauma-related swelling. The final study cohort consisted of 100 patients, of whom 92 (92%) completed follow-up. The participant flow is depicted in Figure 1.

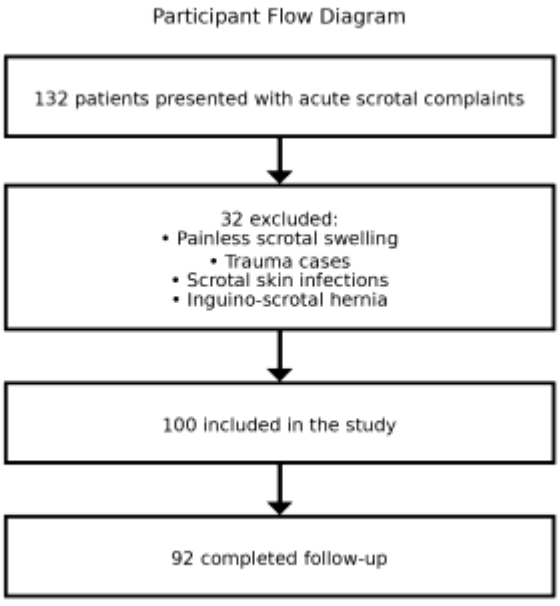

Figure 1. Participant flow diagram

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Table 1. Age distribution of patients with acute scrotum (n=100)

Age Group (years)	Number of Patients	Percentage (%)
<10	5	5%
11–20	28	28%
21–30	27	27%
31–40	18	18%
41–50	12	12%
>50	10	10%

Baseline characteristics

The age of the patients ranged from 5 to 60 years, with a mean age of 22 years. The majority (55%) fell within the 11–30 year age group. Left-sided involvement was seen in 58% of cases, right-sided in 39%, and bilateral in 3%.

Clinical presentation

The most frequent presenting symptom was acute scrotal pain, observed in 92% of patients, followed by swelling (89%), tenderness (93%), and erythema (48%). Fever was present in 36%, and urinary symptoms (dysuria or frequency) in 21%.

Laboratory and Doppler findings

Leukocytosis was observed in 74% of patients diagnosed with epididymo-orchitis, whereas patients with testicular torsion generally demonstrated normal or mildly raised white cell count.

Color Doppler ultrasonography showed:

- Absent or reduced testicular perfusion in 40 patients
- Whirlpool sign in 28 patients
- Increased epididymal vascularity in 36 patients, suggestive of epididymo-orchitis

Findings on Doppler strongly correlated with surgical and clinical outcomes. The etiological distribution is summarized in Table 2 and illustrated in Figure 2.

Table 2. Etiological distribution of acute scrotum (n=100)

Diagnosis	Number of Patients	Percentage (%)
Testicular torsion	44	44%
Epididymo-orchitis	38	38%
Acute hydrocele	7	7%
Scrotal cellulitis/abscess	6	6%
Pyocele	3	3%
Miscellaneous	2	2%

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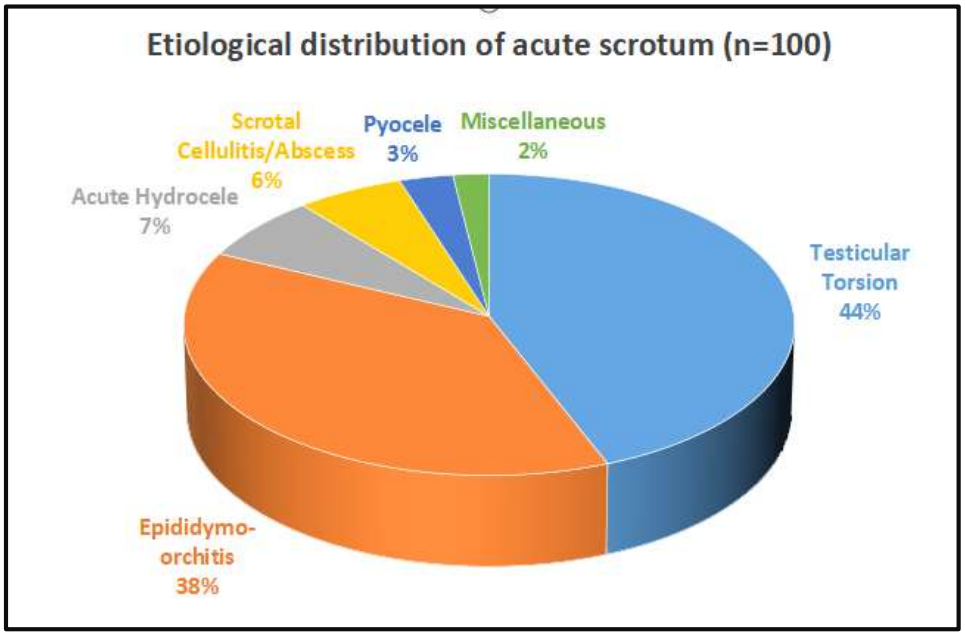

Figure 2: pie chart showing etiological distribution of acute scrotum (n=100)

Patients diagnosed with epididymo-orchitis and acute hydrocele responded well to antibiotics, analgesics, scrotal support, and rest. Pyocele and scrotal abscess cases required surgical drainage.

At 1-month follow-up, 92% of patients reported complete resolution of symptoms, with no major postoperative complications noted. Management outcomes in torsion cases are presented in Table 3.

Table 3. Management outcomes in testicular torsion (n=44)

Surgical Outcome	Number of Patients
Orchidopexy (viable testes)	18
Orchidectomy (non-viable)	26
Contralateral orchidopexy	44

Discussion

In this study, testicular torsion and epididymo-orchitis accounted for the majority of acute scrotum presentations, a pattern consistent with earlier hospital-based studies where these two conditions dominate clinical incidence [10–15]. The relatively high proportion of torsion in younger males in this cohort reflects known anatomical susceptibility, particularly the presence of bell-clapper deformity and increased testicular mobility in this age group [5,14]. These findings emphasize the influence of local demographic profiles in shaping the clinical burden of acute scrotal emergencies.

A key observation in this study was the strong association between the timing of presentation and testicular viability. Patients presenting within a shorter duration of symptoms had a higher likelihood of testicular preservation, whereas those presenting after prolonged pain typically required orchidectomy. This aligns with the well-established concept that testicular viability declines sharply after 6 hours of ischemia, with salvage rates dropping significantly beyond 12 to 24 hours [1,4,7]. The high orchidectomy rate in this cohort underscores persistent delays in healthcare-seeking behavior, influenced by distance, lack of awareness, and reliance on informal treatment practices, as also noted in prior work addressing delayed torsion presentation [16].

Color Doppler ultrasonography was useful in differentiating torsion from inflammatory conditions in most cases. Reduced or absent perfusion favored torsion, whereas

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increased vascularity favored epididymo-orchitis, consistent with findings reported in previous studies assessing Doppler accuracy [8,18]. However, as highlighted in earlier guidelines and literature, Doppler may yield false-negative results in intermittent torsion or early vascular compromise [7,19]. Therefore, this study reinforced that strong clinical suspicion should continue to guide emergency exploration, even if Doppler findings are equivocal.

Conservative management was effective in the majority of patients with epididymo-orchitis and acute hydrocele. Antibiotic therapy, scrotal support, and analgesics resulted in symptomatic improvement in most cases, aligning with recommended treatment practices described in prior clinical reports [6,20]. However, a subset of patients progressed to complications such as pyocele or abscess formation, requiring surgical drainage. This highlights the importance of structured follow-up to detect clinical deterioration early.

The structured diagnostic and treatment protocol implemented in this study facilitated systematic evaluation and streamlined decisions regarding surgical exploration. By integrating clinical assessment with Doppler findings and predefined criteria for operative intervention, the protocol minimized uncertainty and supported timely decisions. Protocol-based management has been shown in other emergency settings to reduce delays and treatment variation, particularly in busy tertiary-care hospitals [12,15]. This aligns well with the workflow demands of such institutions, where resident-level turnover and case load may otherwise introduce inconsistency.

These findings are generalizable to tertiary care centers dealing with similar mixed urban and rural populations. However, outcomes such as testicular salvage remain context-dependent and influenced primarily by time of presentation. Regions with better referral systems and higher health awareness may achieve higher salvage rates than settings where delays are prevalent [14,16]. Therefore, while protocol adoption is important, improvements in community education and first-contact healthcare recognition are equally necessary.

This study benefited from its prospective design, standardized documentation, and high follow-up rate, which contribute to the robustness of the findings. Nevertheless, limitations include the single-center design and relatively short follow-up, which did not allow for the evaluation of long-term outcomes, such as testicular atrophy or fertility status. Similar limitations have been noted in earlier observational studies of acute scrotum [13,20]. Future multi-center studies with extended follow-up would be valuable in assessing the reproductive implications and validating the effectiveness of the protocol across various healthcare settings.

Conclusion

The acute scrotum is a clinical emergency that requires rapid assessment and appropriate intervention. In this study, testicular torsion and epididymo-orchitis were identified as the leading causes, with timely presentation being the key determinant of testicular salvage in torsion cases. Color Doppler ultrasonography proved highly valuable in differentiating torsion from inflammatory causes, but clinical suspicion must continue to guide urgent surgical exploration. Implementation of a structured diagnostic and management protocol improves decision-making, reduces treatment delays, and enhances clinical outcomes in patients presenting with an acute scrotum.

Strengths:

- Prospective study design with systematic clinical and radiological evaluation.
- Implementation and assessment of a structured protocol in a real-world tertiary care setting.
- High follow-up rate (92%), ensuring reliable outcome assessment.

Limitations:

- Single-center study, which may limit external applicability to different healthcare environments.
- Short follow-up duration, which did not allow assessment of long-term outcomes such as testicular atrophy or fertility impact.
- Surgical decisions were operator-dependent, which may introduce minor inter-observer variation.

Recommendations

- Awareness programs are needed at the community and primary healthcare levels to minimize delay in seeking evaluation for acute scrotal pain.
- Emergency care protocols should prioritize immediate clinical assessment and Doppler ultrasonography in suspected torsion.
- Hospitals should adopt standardized acute scrotum management pathways to improve testicular salvage rates.
- Further multicentric studies with long-term follow-up are recommended to assess reproductive

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outcomes following different treatment approaches.

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List of abbreviations
CBC: Complete Blood Count
RBS: Random Blood Sugar
USG: Ultrasonography
Doppler: Color Doppler Ultrasonography
IEC: Institutional Ethics Committee

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This study did not receive any external funding. It was conducted as part of routine academic and clinical practice.

Conflict of interest
The authors declare no conflicts of interest.

Author contribution
First Author Concept, study design, data collection, patient management
Second Author: Statistical analysis, interpretation of results, manuscript drafting
Third Author: Critical revision of manuscript, surgical supervision, final approval

Data availability statement
The datasets generated and analyzed during the current study are available from the corresponding author on reasonable request.

Author biography
Dr. Kumar Mrigesh is an Assistant Professor in the Department of General Surgery at Netaji Subhas Medical College, Bihta, Patna, Bihar. His areas of interest include emergency surgical care, urological emergencies, and protocol-based clinical management. He has contributed to multiple academic and clinical research initiatives in general and urological surgery.

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