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Validity of Color Versus Spectral Doppler Ultrasound Indices in Post-Surgical Cases of Testicular Torsion

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Abstract:

Objective:

To evaluate the diagnostic accuracy of Color Doppler and Spectral Doppler ultrasound indices in detecting testicular torsion in post-surgical cases.

Methods:

A retrospective study was conducted over six months in the Department of Radiology, Benazir Bhutto Hospital, Rawalpindi. Seventy-one male patients with clinical suspicion of testicular torsion were assessed using both Color and Spectral Doppler ultrasound. Findings were compared with surgical exploration results. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy were calculated.

Results:

The mean patient age was 15.2 years. Of 71 patients, 56 (78.9%) were diagnosed with torsion on ultrasound, and 60 (84.5%) were confirmed surgically. Color/Spectral Doppler demonstrated 91.66% sensitivity, 90.9% specificity, PPV of 98.21%, NPV of 66.6%, and an overall diagnostic accuracy of 91.5%.

Conclusion:

Color and Spectral Doppler ultrasound are highly sensitive and specific, offering reliable, non-invasive diagnostic modalities for post-surgical evaluation of testicular torsion. Their appropriate use can prevent unnecessary surgical exploration and improve clinical outcomes.

Keywords:
Testicular torsion, Doppler ultrasound, Color Doppler, Spectral Doppler, Resistive Index, Radiology, Post-surgical evaluation

Introduction

Testicular torsion constitutes a urological emergency characterized by twisting of the spermatic cord, resulting in vascular compromise and subsequent ischemia. Prompt diagnosis and surgical intervention are critical to preserving testicular viability. Although rare, its clinical presentation necessitates immediate differentiation from other causes of acute scrotum to mitigate irreversible damage[1].

Color and Spectral Doppler ultrasonography (CDUS and SDUS) serve as cornerstone diagnostic tools, offering non-invasive assessment of testicular blood flow. CDUS assesses perfusion patterns, whereas SDUS quantifies resistive indices (RI), facilitating a more nuanced understanding of vascular compromise[2].

While surgical exploration remains the gold standard, the role of Doppler ultrasound in post-operative evaluation remains under continuous investigation. This study seeks to establish the diagnostic validity of CDUS and SDUS in detecting testicular torsion, particularly in the post-surgical setting, and to compare findings with operative outcomes.

Materials and Methods

A retrospective cross-sectional study was conducted in the Radiology Department of Benazir Bhutto Hospital, Rawalpindi, over six months (Jan 2024 to June 2024) following ethical clearance. A total of 71 male patients presenting with clinical suspicion of testicular torsion were included. Inclusion criteria comprised all age groups with a TWIST score >2. Patients with epididymo-orchitis or delayed presentation requiring immediate exploration were excluded.

All patients underwent Color and Spectral Doppler ultrasound using standard protocols. Blood flow was categorized as absent, decreased, or increased. The intratesticular arterial resistive index (RI) was measured, with values >0.75 considered suggestive of torsion.Surgical exploration served as the definitive diagnostic reference. Intraoperative findings were documented and correlated with ultrasound results. Data were analyzed using SPSS 23.0. Sensitivity, specificity, PPV, NPV, and overall diagnostic accuracy were calculated.

Results

A total of 71 patients were included in the study, with a mean age of 15.2 ± 4.4 years (range: 1–25 years). The most frequent age was 14 years. The mean resistive index (RI) among patients with testicular pathologies was 0.82 ± 0.13.
On Doppler ultrasound, 45 patients (63.4%) demonstrated absent intratesticular blood flow, 20 (28.2%) showed decreased flow, and 6 (8.4%) exhibited increased flow patterns. Ultrasound identified 56 cases (78.9%) of testicular torsion, while surgical exploration confirmed torsion in 60 cases (84.5%).
Among the surgically confirmed torsion cases, orchiectomy was performed in 40 patients (67%), whereas orchiopexy was carried out in 20 patients (33%).
When comparing Doppler ultrasound with surgical findings, the diagnostic performance was as follows: sensitivity 91.66%, specificity 90.9%, positive predictive value (PPV) 98.21%, negative predictive value (NPV) 66.6%, and overall accuracy 91.5%.

Table 1: Surgical Outcomes among Torsion Cases (n = 60)

Procedure	n	%
Orchiectomy	40	67

Orchiopexy	20	33

Table 2: Diagnostic Accuracy of Doppler Ultrasound

Metric	Value (%)
Sensitivity	91.66
Specificity	90.9
Positive Predictive Value (PPV)	98.21
Negative Predictive Value (NPV)	66.6
Overall Accuracy	91.5

Discussion

Discussion

The mean age of our cohort was 15.2 ± 4.4 years, reflecting the adolescent peak of torsion, though slightly older than large pediatric databases, where the mean is ~10 years[3,4]. This difference may explain the relatively high orchiectomy rate in our series, since delayed presentation is well known to reduce salvage [5].

Color Doppler ultrasound (CDUS) demonstrated high diagnostic performance with sensitivity (91.6%), specificity (90.9%), and PPV (98.2%) comparable to prior studies.[6,7] Our specificity was slightly lower than some optimized series (98.8%[4]) but higher than others (68.4%[7]), emphasizing operator dependence. Importantly, our NPV was modest (66.6%), consistent with the recognized risk of false-negatives in torsion with preserved flow.[8]

In our cohort, absent flow was noted in 63.4% of cases, decreased flow in 28.2%, and increased flow in 8.4%. This spectrum reflects evolving or intermittent torsion and underscores the diagnostic challenge of preserved or increased perfusion, as highlighted by Bandarkar & Blask.[8] Reliance solely on global perfusion may obscure critical sonographic signs such as the whirlpool sign, abnormal testicular lie, or focal avascular regions.[8]

We observed slight discordance between ultrasound (56 torsion diagnoses) and surgery (60 torsions), in keeping with reports that clinical judgment should override imaging in equivocal cases.[2,4,6] Concerns regarding diagnostic delay are also supported by Chen & Esler, who reported a 3.5-hour mean delay attributable to ultrasound.[5] This reinforces recommendations for immediate exploration in high-suspicion cases, reserving CDUS for less clear presentations.[2,5,6]

Our orchiectomy rate (67%) exceeded the ~42% reported in national databases,[3] reflecting late presentation and systemic delays. This highlights the urgent need for public awareness, rapid referral, and streamlined diagnostic pathways.

Conclusion

Doppler ultrasound, particularly the combination of Color and Spectral modalities; offers a reliable, non-invasive, and cost-effective diagnostic tool for evaluating suspected testicular torsion. With high sensitivity and specificity, it enables timely intervention and reduces unnecessary surgical exploration.

Its use in post-surgical settings remains valid and should be incorporated into standardized protocols for acute scrotal pain evaluation. However, clinicians must remain cautious in interpreting equivocal cases, with surgical exploration retained as the gold standard where diagnostic uncertainty persists.

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