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RESEARCH ARTICLE

Role of early ultrasonography of whole abdomen and thorax in predicting severe illness in dengue patients in addition to clinical and lab parameters

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Abstract: Dengue fever is a rapidly spreading mosquito-borne viral illness with a wide clinical spectrum ranging from mild to severe disease. Early identification of severe dengue is crucial for effective management. Ultrasonography (USG) has emerged as a valuable, non-invasive tool for detecting early signs of plasma leakage before clinical deterioration. This study aimed to assess the role of early ultrasonographic findings of the whole abdomen and thorax in predicting severe illness in dengue patients alongside clinical and laboratory parameters.This prospective observational study was conducted on 100 serologically confirmed dengue IgM-positive adult patients at a tertiary care hospital over one year. Patients underwent clinical evaluation, laboratory investigations including platelet count, and a single-time ultrasound examination. USG findings such as gallbladder (GB) wall edema, ascites, pleural effusion, hepatosplenomegaly, and perinephric edema were documented. Dengue severity was classified per WHO guidelines, and statistical analysis was performed to assess associations.Among the 100 patients, 68% had mild and 32% had severe dengue. GB wall edema (79%), ascites (64%), and pleural effusion (55%) were the most common sonographic findings. All were significantly more prevalent in severe dengue ($p < 0.001$). Perinephric edema was also significantly associated with severe cases. USG abnormalities showed an inverse correlation with platelet counts, with patients having counts <40,000/μL exhibiting the highest prevalence of abnormal findings.Early ultrasonographic evaluation, particularly detection of GB wall edema, ascites, and pleural effusion, serves as a reliable predictor of severe dengue. USG should be integrated into early assessment protocols to guide timely clinical decision-making.

Keywords: Ultrasonogram; dengue; edema; ascites; pleural effusion

INTRODUCTION

Dengue fever is a mosquito-borne viral illness caused by a single-stranded RNA virus of the Flaviviridae family, transmitted primarily by Aedes aegypti mosquitoes. It is endemic in over 100 countries, with a high burden observed in Southeast Asia, including India, Indonesia, Thailand, Myanmar, Sri Lanka, and Bangladesh [1]. There are four known serotypes of the dengue virus (DENV-1 to DENV-4), and while infection with a single serotype may lead to mild or asymptomatic disease, sequential infection with different serotypes significantly increases the risk of developing severe dengue [2].

Symptomatic dengue infection is a dynamic systemic illness that may present with a wide clinical spectrum ranging from mild dengue fever (DF) to severe dengue (SD). Severe forms are characterized by plasma leakage, pleural or abdominal effusion, bleeding, and organ dysfunction, leading to increased morbidity and mortality [3]. Early identification of patients at risk of progression to severe dengue is critical for timely clinical intervention, close monitoring, and improved outcomes [4].

Historically, classification systems by the World Health Organization (WHO) categorized dengue as classical dengue and dengue haemorrhagic fever (DHF). However, due to changes in epidemiology and clinical presentations, WHO revised its classification in 2009, now identifying cases as dengue with or without warning signs, and severe dengue [5]. DHF is associated with increased vascular permeability, leading to fluid leakage and accumulation, detectable in early stages before clinical deterioration sets in [6].

Although laboratory parameters such as hematocrit, platelet count, and serum albumin have been routinely used to monitor patients, they often fail to detect early plasma leakage. Serological confirmation of dengue also involves time delays, limiting its utility in early disease prediction [7]. In this context, ultrasonography (USG) has emerged as a valuable point-of-care tool that can identify early features of plasma leakage such as gallbladder wall thickening, pericholecystic fluid, ascites, pleural effusion, and hepatosplenomegaly. These findings are known to precede clinical deterioration and may serve as early predictors of severe dengue [8].

Several studies have demonstrated the role of ultrasound in detecting early signs of dengue complications, particularly in pediatric populations. However, comprehensive evaluation of early thoracic and abdominal ultrasonographic findings in adult

patients, and their correlation with clinical and laboratory parameters, remains limited [9]. Furthermore, there is a lack of standardized ultrasound protocols tailored to the early detection of severe dengue in resource-constrained settings [10]. Therefore, this study was conducted to assess the role of early ultrasonographic evaluation of the whole abdomen and thorax in predicting severe illness in patients with dengue fever.

MATERIAL AND METHODS

This prospective observational study was conducted in the Department of General Medicine at Meenakshi Medical College Hospital and Research Institute (MMCHRI), Enathur, Kanchipuram. The study was carried out over a one-year period from December 2023 to November 2024. Approval for the study was obtained from the Institutional Ethics Committee prior to the commencement of data collection.

The study included adult patients admitted with clinical suspicion of dengue fever who tested positive for dengue IgM antibodies. Patients were recruited after obtaining informed written consent. Inclusion criteria comprised patients aged more than 13 years, with a history of fever and positive dengue IgM serology. Patients were excluded if they were less than 13 years of age, did not consent to participation, or had a known history of chronic liver disease, cholelithiasis, chronic renal failure, congestive cardiac failure, or idiopathic thrombocytopenic purpura (ITP). A total of 100 patients fulfilling the inclusion criteria and testing positive for dengue IgM were enrolled in the study. The sample size of 100 was chosen based on the average annual admission rate of dengue cases in our institution during the previous two years , ensuring adequate statistical power for detecting clinically significant associations between ultrasonographic findings and disease severity within available study period.

After obtaining informed consent, clinical and demographic data were recorded in a predesigned proforma. Relevant investigations including platelet count, hematocrit levels, and blood pressure were monitored. All enrolled patients underwent ultrasonography of the whole abdomen, pelvis, and thorax using a Sonoscape ultrasound machine equipped with 3.5 MHz and 5 MHz probes. Scans were performed by an experienced radiologist following a minimum fasting period of six hours to allow optimal visualization of the gallbladder. Each patient was examined only once to eliminate inter-observer variability. Sonographic parameters assessed included gallbladder wall thickening, pericholecystic fluid, ascites, pleural effusion, pericardial effusion, hepatomegaly, splenomegaly, and perinephric edema.
Dengue severity was classified based on WHO guidelines. Dengue fever (DF), DHF Grade I, and DHF Grade II were categorized as mild dengue, while DHF Grade III (Dengue Shock Syndrome) and DHF Grade IV (profound shock) were classified as severe dengue.

Statistical Analysis

Data collected were coded and entered into Microsoft Excel and analyzed using SPSS version 25.0. Continuous variables were expressed as mean, median, and standard deviation. Depending on the normality of the distribution, parametric tests such as the independent t-test or ANOVA were used, while non-parametric tests were employed when appropriate. Categorical data were presented as frequencies and proportions. The Chi-square test was used to determine associations between categorical variables, and Fisher's exact test was applied when expected cell counts were below five. A p-value of less than 0.05 was considered statistically significant.

Conflict of Interest

There were no conflicts of interest declared by the authors.

RESULTS AND OBSERVATIONS:

A total of 100 patients with serologically confirmed dengue IgM positivity were included in this study. The study population comprised 61 males (61%) and 39 females (39%), showing a clear male predominance. The majority of patients fell within the 21–30 years age group (32%), followed by those aged 31–40 years (24%), above 40 years (20%), 16–20 years (18%), and 13–15 years (6%).

Based on clinical evaluation, laboratory findings, and ultrasonographic parameters, patients were classified into two groups according to WHO criteria: **mild dengue** (n = 68) and **severe dengue** (n = 32). The distribution of clinical features between these two groups is presented in **Table 1**.

- Table 1 showed the clinical profile which revealed that fever was universal across both groups. Other symptoms such as vomiting, abdominal pain, petechiae, and melena were more commonly observed in severe dengue patients and were statistically significant. Splenomegaly and central nervous system involvement also showed a notable association with severity. All patients with severe dengue exhibited hypotension, while none in the mild group did. Hepatomegaly, although more common in severe dengue, did not reach statistical significance.

Table 1: Clinical Features in Mild and Severe Dengue

Clinical Feature	Total (n=100)	Mild Dengue (n=68)	Severe Dengue (n=32)	P value
Fever	100 (100%)	68 (100%)	32 (100%)	<0.001
Vomiting	49 (49%)	28 (41.18%)	21 (65.62%)	<0.001
Abdominal Pain	58 (58%)	29 (42.65%)	29 (90.62%)	<0.001
Petechiae	66 (66%)	41 (60.29%)	25 (78.12%)	0.002
Melena	55 (55%)	39 (57.35%)	16 (50%)	<0.001
Splenomegaly	28 (28%)	11 (16.18%)	17 (53.12%)	<0.001
Hepatomegaly	43 (43%)	26 (38.23%)	17 (53.12%)	0.38
CNS Involvement	7 (7%)	1 (1.47%)	6 (18.75%)	<0.001
Hypotension	32 (32%)	0 (0%)	32 (100%)	<0.001

All 100 patients underwent ultrasound evaluation of the abdomen and thorax. A detailed comparison of ultrasonographic abnormalities between mild and severe dengue cases is shown in **Table 2**.

The proportion of severe dengue was higher in male patients (21 out of 61; 34.4%) compared to female patients (11 out of 39; 28.2%), although the difference was not statistically significant. Most patients with severe dengue were found to have positive ultrasonographic findings suggestive of plasma leakage, including ascites, pleural effusion, gallbladder wall thickening, or hepatosplenomegaly.

Table 2 describes the most frequently observed sonographic abnormality was gallbladder wall edema, noted in 79% of patients. It was universally present in those with severe dengue (100%) and significantly more common than in the mild group ($p < 0.001$). Ascites and pleural effusion were also key findings, present in all patients with severe disease. Perinephric edema, though less common overall (16%), showed a strong association with severity, being detected in over 40% of severe cases. In contrast, hepatomegaly was observed in both groups without significant correlation to severity. These findings underscore the role of ultrasound in early identification of plasma leakage in dengue infection.

Table 2: Ultrasonographic Findings in Mild and Severe Dengue

USG Feature	Total (n=100)	Mild Dengue (n=68)	Severe Dengue (n=32)	P value
Pleural Effusion	55 (55%)	28 (41.17%)	27 (84.37%)	<0.001
GB Wall Edema	79 (79%)	47 (69.11%)	32 (100%)	<0.001
Ascites	64 (64%)	32 (47.05%)	32 (100%)	<0.001
Hepatomegaly	59 (59%)	41 (60.29%)	18 (56.25%)	0.42
Splenomegaly	33 (33%)	19 (27.94%)	14 (43.75%)	<0.001
Perinephric Edema	16 (16%)	3 (4.41%)	13 (40.62%)	<0.001

Patients were then categorized based on platelet counts into three groups:

- Group A: <40,000/µL (n=44)
- Group B: 40,000–80,000/µL (n=32)
- Group C: 80,000–150,000/µL (n=24)

The correlation of USG findings with platelet count is detailed in **Table 3**

Table 3 shows a strong inverse correlation was observed between platelet levels and the presence of abnormal ultrasonographic findings. Gallbladder wall edema was the most frequently encountered sonographic feature in all three groups, with the highest prevalence in Group A (93.18%), followed closely by Group B (90.62%), and significantly less in Group C (45.83%) ($p < 0.001$). This trend reflects the potential of gallbladder wall thickening as an early indicator of severity in patients with thrombocytopenia.

Pleural effusion followed a similar distribution, being present in 68.18% of patients in Group A, decreasing to 37.5% in Group B and 29.16% in Group C, demonstrating a statistically significant association ($p < 0.001$). Ascites showed a comparable pattern, observed in 88.63% of patients with the lowest platelet counts, but markedly less frequent in Groups B (40.62%) and C (16.66%) ($p < 0.001$). These findings underscore the diagnostic utility of USG in detecting early plasma leakage among patients with severe thrombocytopenia.

Although hepatomegaly appeared more frequently in Group A (79.54%) compared to Groups B (43.75%) and C (25%), the association did not reach statistical significance ($p = 0.48$). Splenomegaly, however, did exhibit a statistically significant correlation with low platelet counts, being more common in Group A (43.18%) than in Group B (25%) and Group C (16.66%) ($p = 0.026$).

Interestingly, normal ultrasonographic findings were predominantly seen in patients with higher platelet counts. While only 2.27% of patients in Group A had normal scans, this increased to 9.37% in Group B and significantly to 41.66% in Group C. However, the association between normal USG and platelet count did not reach statistical significance (p = 0.56).

Overall, the analysis reveals that most ultrasonographic abnormalities—particularly GB wall edema, ascites, and pleural effusion—are significantly associated with lower platelet counts, further reinforcing the role of thrombocytopenia as a surrogate marker for plasma leakage and severe dengue

Table 3: Correlation of USG Findings with Platelet Count

USG Feature	<40,000/µL (n=44)	40,000–80,000/µL (n=32)	80,000–150,000/µL (n=24)	P value
GB Wall Edema	41 (93.18%)	29 (90.62%)	11 (45.83%)	<0.001
Pleural Effusion	30 (68.18%)	12 (37.50%)	7 (29.16%)	<0.001
Ascites	39 (88.63%)	13 (40.62%)	4 (16.66%)	<0.001
Hepatomegaly	35 (79.54%)	14 (43.75%)	6 (25%)	0.48
Splenomegaly	19 (43.18%)	8 (25%)	4 (16.66%)	0.026
Normal USG	1 (2.27%)	3 (9.37%)	10 (41.66%)	0.56

DISCUSSION

In our study comprising 100 serologically confirmed IgM-positive dengue patients, males constituted 61% of the study population, indicating a clear male predominance. This observation is consistent with previous reports [7,11], likely attributable to greater outdoor exposure and occupational activity in males. Fever was present in all patients (100%), aligning with the classical dengue presentation and consistent across the literature. Vomiting (49%), abdominal pain (58%), petechiae (66%), and melena (55%) were commonly observed, with significantly higher frequencies in severe dengue cases. Petechiae emerged as the most common bleeding manifestation in our study (78.12% in severe cases), differing from some studies where hematemesis was more frequently observed [11,12]. Central nervous system (CNS) involvement was reported in 7% of patients, predominantly in the severe group (18.75%), while hypotension was present in all patients classified with severe dengue (100%) and none in the mild group, reflecting disease severity and matching the WHO criteria for severe dengue.

Ultrasound evaluation played an important role in assessing complications and predicting severity in our study population. Gallbladder (GB) wall edema was the most common ultrasonographic finding, present in 79% of patients overall. All patients with severe dengue (100%) demonstrated GB wall thickening, compared to 69.11% in the mild group (p < 0.001). This finding aligns closely with previous studies reporting GB wall thickening in 100% of pediatric dengue cases [7,11], while another study noted a slightly lower frequency of 66.7%, with a higher prevalence (97.8%) among patients with platelet counts below 40,000/µL [13]. Additional evidence supports GB wall edema as an early and sensitive marker of plasma leakage, exhibiting a high positive predictive value for severe dengue when considered alongside thrombocytopenia and clinical warning signs [14,15].

Ascites was the second most frequent finding, observed in 64% of all patients. It was significantly more common in severe dengue cases (100%) compared to mild cases (47.05%) (p < 0.001). These results are comparable to previous reports showing ascites prevalence of 75% [11], 64.5% [13], and 27.3% in pediatric patients [12]. The role of ascites as a reliable early indicator of severity has been further supported by larger cohort studies advocating its inclusion in sonographic dengue severity scoring systems [16].

Pleural effusion was observed in 55% of cases in our study and showed a significant association with disease severity (84.37% in severe cases vs. 41.17% in mild cases; p < 0.001). This finding is consistent with previous reports of 70% [11] and 50% [13], whereas another pediatric study reported pleural effusion in 15.2% (right-sided) and 21.2% (bilateral) of patients [12]. Recent evidence indicates that bilateral pleural effusions, particularly when accompanied by ascites, are linked to an increased risk of shock and longer hospital stays [17].

Splenomegaly was identified in 33% of patients, with a significantly higher prevalence in the severe group (43.75%) compared to mild cases (27.94%) (p < 0.001). Previous studies have reported splenomegaly in 40% [11] and 16.7% [13] of cases, with variability potentially due to differences in geographic viral strains, patient age groups, and stages of disease. Hepatomegaly was observed in 59% of our cases but showed no significant correlation with disease severity (p = 0.42). Similar proportions have been reported in (17.7%) [13] and (39.4%) [12]. Nevertheless, meta-analyses suggest that hepatomegaly may still serve as a supportive indicator in pediatric and mixed-age dengue populations [18].

Perinephric fluid collection, a less commonly reported finding, was observed in 16% of our cases and showed a significant association with severe dengue (40.62% vs. 4.41% in mild cases; $p < 0.001$). This is consistent with previous observations reporting perinephric fluid in 15.2% of pediatric dengue cases [12]. Emerging evidence suggests that perinephric edema may be underrecognized but occurs frequently in dengue shock syndrome [19].

Sonographic abnormalities demonstrated an inverse correlation with platelet counts. In patients with platelet counts below 40,000/µL, the prevalence of gallbladder wall edema (93.18%), ascites (88.63%), and pleural effusion (68.18%) was significantly higher. These findings decreased with increasing platelet counts, underscoring thrombocytopenia's role as a marker of plasma leakage and disease severity. This pattern aligns with previous reports showing gallbladder wall thickening in 97.8%, ascites in 86.9%, and pleural effusion in 58.6% of patients with platelet counts under 40,000/µL, while patients with counts above 150,000/µL exhibited no abnormal ultrasonographic findings [13]. Additionally, a significant correlation between the number of positive sonographic findings and disease severity has been documented ($p < 0.05$) [12]. Therefore, combining ultrasonography with platelet and hematocrit trends may improve triage accuracy, particularly in settings with delayed or limited laboratory diagnostics [20].

All patients in our study recovered successfully, with no mortality reported. Early diagnosis through ultrasonographic evaluation, combined with clinical and laboratory parameters, proved valuable for effective triaging and optimizing patient care. Ultrasound, being a non-invasive, repeatable, and widely accessible modality, detects early signs of plasma leakage. Our findings reinforce the diagnostic significance of ultrasonography—particularly gallbladder wall edema, ascites, pleural effusion, and perinephric fluid collection—in assessing disease severity. In addition to its diagnostic value, ultrasound offers notable cost effectiveness in dengue endemic regions, as it is increasingly available in primary care and district level hospitals. Its rapid turnaround, minimal operating costs after initial procurement, and absence of radiation exposure make it a practical option for integration into existing triage protocols. Incorporating targeted sonographic assessment of dengue patients at the primary care level may enable earlier identification of severe cases, reduce unnecessary referrals, and optimize resource allocation in higher tier facilities. These results align with existing literature and support the integration of ultrasound into dengue management protocols, especially in resource-limited settings.

CONCLUSION:

This study highlights the pivotal role of early ultrasonography in predicting the severity of dengue fever. Sonographic features such as gallbladder wall edema, ascites, pleural effusion, and perinephric edema were significantly associated with severe dengue and correlated inversely with platelet count. Gallbladder wall edema emerged as the most common and sensitive indicator of severe illness.

These findings are consistent with recent literature emphasizing that ultrasound, when applied systematically, can detect subclinical plasma leakage earlier than conventional clinical signs or lab values [21]. The findings confirm that USG, when combined with clinical and laboratory parameters, is a potentially valuable, non-invasive tool for early identification and management of patients at risk of severe dengue, especially in resource-limited settings. However, before widespread adoption, there is a critical need for large, well designed multicentric studies to validate these results across different populations and healthcare levels . Such evidence would strengthen its role in WHO endorsed dengue care frameworks and help standardize USG based severity scoring systems [22].

Limitation:

This single-centre study with a limited sample size may not be generalizable. Single-time, operator-dependent ultrasound evaluations and exclusion of paediatric patients further restrict the scope and applicability of the findings.

Conflict of Interest

None.

Source of Funding

None.

Authorship Contribution Statement

Dinesh Chandra Chellagundla: Experimentation and Writing-original draft, Meyyammai Chidambaram: Review and editing, Rahul Rao Sadamala: Review and editing, Srinivasagalu Krishnasamy: Conceptualization and supervision

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