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Original Research Article

RADIOLOGICAL AND LABORATORY CORRELATION OF PLASMA LEAKAGE IN DENGUE INFECTION USING CHEST AND ABDOMINAL ULTRASONOGRAPHY

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ABSTRACT

Background: Dengue Fever is a rapidly spreading vector-borne illness in tropical and subtropical regions. Plasma leakage due to increased vascular permeability is a key feature of severe dengue and may lead to complications such as pleural effusion, ascites, and shock. Early identification of plasma leakage is essential for timely clinical management. Ultrasonography of the chest and abdomen has emerged as a useful non-invasive modality for detecting early radiological evidence of plasma leakage. The objective is to evaluate the radiological and laboratory correlation of plasma leakage in dengue infection using chest and abdominal ultrasonography.

Materials and Methods: This hospital-based observational study included 100 patients with serologically confirmed dengue infection. Demographic details, clinical findings, and laboratory parameters such as platelet count and hematocrit levels were recorded. All patients underwent thoracoabdominal ultrasonography to detect radiological signs of plasma leakage, including pleural effusion, ascites, gallbladder wall thickening, and pericardial effusion. The ultrasonographic findings were correlated with laboratory parameters. Statistical analysis was performed using appropriate tests, and a p-value <0.05 was considered statistically significant.

Results: The mean age of the patients was 34.6 ± 11.2 years, with a male predominance (58% males). Ultrasonographic findings suggestive of plasma leakage were observed in 54% of patients. The most common findings were gallbladder wall thickening (38%), followed by ascites (32%) and pleural effusion (28%). Patients with ultrasonographic evidence of plasma leakage had significantly lower platelet counts (58,300 ± 18,200 cells/mm³) and higher hematocrit levels (44.2 ± 4.9%) compared to those without plasma leakage ($p < 0.001$).

Conclusion: Chest and abdominal ultrasonography is a valuable, non-invasive tool for the early detection of plasma leakage in dengue infection. When combined with laboratory parameters, it can help identify patients at risk of severe disease and support timely clinical management.

Keywords: Dengue fever, Plasma leakage, Ultrasonography, Pleural effusion, Hematocrit.

INTRODUCTION

Dengue Fever is one of the most rapidly spreading vector-borne viral diseases worldwide and represents a major public health concern, particularly in tropical and subtropical regions. The disease is caused by the dengue virus, a member of the Flavivirus genus, and is transmitted primarily through the bite of infected mosquitoes, especially Aedes aegypti. Over the past few decades, the global incidence of dengue infection has increased dramatically, with a substantial burden observed in Asia.[1] According to the World Health Organization, the number of reported dengue cases rose from approximately 2.2 million in 2010 to about 3.2 million in 2015.[1] More recently, 2023 witnessed an unprecedented surge in dengue activity worldwide, with more than 6.5 million reported cases and over 7,300 dengue-related deaths.[2] In addition

to increasing case numbers, dengue transmission has expanded geographically to several previously unaffected regions, further emphasizing its growing global impact.[3] Dengue infection presents with a broad clinical spectrum ranging from asymptomatic infection and mild febrile illness to severe and life-threatening complications. Based on current clinical guidelines, dengue infection is generally classified into three categories: dengue fever, dengue with warning signs, and severe dengue. Warning signs such as persistent vomiting, abdominal pain, mucosal bleeding, lethargy, hepatomegaly, clinical fluid accumulation, and rising hematocrit levels may indicate progression to severe disease.[1] Patients who develop severe plasma leakage, significant hemorrhage, or organ dysfunction are classified as having severe dengue and often require hospital admission and intensive monitoring.[1] The natural course of dengue infection typically progresses through three phases: the febrile phase, the critical phase, and the recovery phase. During the early febrile phase, it is often difficult to predict which patients will progress to more severe forms of the disease. As the illness enters the critical phase, increased vascular permeability may lead to plasma leakage, resulting in complications such as pleural effusion, ascites, hemoconcentration, and circulatory shock. Plasma leakage is therefore considered the hallmark of severe dengue and a major contributor to disease-related morbidity and mortality.[4] Early recognition of plasma leakage is essential for timely clinical intervention and prevention of severe outcomes. Laboratory parameters such as thrombocytopenia and rising hematocrit levels are commonly used as indicators of plasma leakage. The World Health Organization recommends monitoring a rapid decline in platelet count accompanied by an increase in hematocrit as a warning sign for plasma leakage.[1] However, interpretation of hematocrit values can be challenging due to factors such as unknown baseline hematocrit levels, dehydration, hemorrhage, excessive fluid replacement, or hemodilution, which may limit its reliability when used alone.[5] In addition to laboratory findings, evidence of plasma leakage may also be detected clinically or through radiological imaging. Imaging modalities can reveal features such as pleural effusion, ascites, and other signs of fluid accumulation. Among these modalities, ultrasonography has emerged as a valuable, non-invasive, and widely accessible diagnostic tool for detecting early manifestations of plasma leakage. Sonographic findings commonly associated with dengue infection include gallbladder wall thickening, pleural effusion, ascites, and occasionally pericardial effusion.[6,7] Thoracoabdominal ultrasonography has been reported to be more sensitive than clinical examination in detecting small amounts of pleural or abdominal fluid, making it an important modality for early assessment and monitoring.[8] Although the use of ultrasonography for identifying plasma leakage in severe dengue has been well established, its role in the early phase of dengue infection remains less clearly defined. Previous studies investigating the role of ultrasound in early dengue have been limited by relatively small sample sizes and single-time imaging performed during admission rather than serial evaluation throughout the disease course.[6,9] Consequently, evidence regarding the correlation between radiological findings and laboratory parameters in the early detection of plasma leakage remains limited.

Therefore, establishing a correlation between radiological findings on chest and abdominal ultrasonography and laboratory parameters may enhance early identification of plasma leakage and improve risk stratification in patients with dengue infection. In this context, the present study aims to evaluate the radiological and laboratory correlation of plasma leakage in dengue infection using chest and abdominal ultrasonography, thereby contributing to improved diagnostic assessment and clinical management of dengue patients.

MATERIALS AND METHODS

This study was conducted as a hospital-based observational study to evaluate the radiological and laboratory correlation of plasma leakage in patients with dengue infection. The study was carried out in the Department of Medicine at a tertiary care hospital.

Study Population: A total of 100 patients diagnosed with dengue infection were included in the study. Patients who presented with clinical features suggestive of dengue fever and had laboratory confirmation of dengue infection were enrolled consecutively during the study period.

Inclusion Criteria

Patients were included in the study if they met the following criteria:

Patients with confirmed dengue infection based on serological tests (NS1 antigen and/or IgM antibody positivity).

Patients aged ≥18 years presenting with clinical features suggestive of dengue fever.

Patients who underwent both laboratory investigations and ultrasonographic examination of the chest and abdomen during the course of illness.

Exclusion Criteria

Patients were excluded from the study if they had:

Pre-existing liver disease, cardiac disease, or renal disease that could influence fluid accumulation.

Other infectious or inflammatory conditions associated with pleural effusion or ascites.

Incomplete clinical, laboratory, or ultrasonographic data.

Clinical and Laboratory Evaluation: All enrolled patients underwent detailed clinical evaluation at the time of admission. Relevant demographic information and clinical features were recorded. Laboratory investigations included complete blood count, platelet count, hematocrit levels, and liver function tests. These parameters were used to assess

disease severity and possible evidence of plasma leakage. A declining platelet count and rising hematocrit levels were considered important laboratory indicators suggestive of plasma leakage.

Ultrasonographic Examination

Ultrasonographic evaluation of the chest and abdomen was performed using a standard diagnostic ultrasound machine by an experienced radiologist. The examination focused on identifying radiological features suggestive of plasma leakage.

The ultrasonographic parameters assessed included:

Presence of pleural effusion
Presence of ascites
Gallbladder wall thickening
Pericholecystic fluid
Presence of pericardial effusion

Both thoracic and abdominal regions were systematically examined. Pleural spaces were assessed for fluid accumulation, while the abdominal cavity was evaluated for ascites and gallbladder wall changes. Gallbladder wall thickness greater than normal limits was considered suggestive of edema associated with plasma leakage.

Assessment of Plasma Leakage: Evidence of plasma leakage was determined based on radiological findings detected on ultrasonography, including pleural effusion, ascites, gallbladder wall thickening, and pericholecystic fluid. These findings were correlated with laboratory parameters such as platelet count and hematocrit levels.

Data Collection and Statistical Analysis

All clinical, laboratory, and ultrasonographic findings were recorded in a structured data collection sheet. The collected data were compiled and analyzed to determine the correlation between radiological findings and laboratory parameters indicative of plasma leakage. Descriptive statistics such as frequencies and percentages were used to summarize the data. Appropriate statistical tests were applied to evaluate the association between ultrasonographic findings and laboratory variables. A p-value of less than 0.05 was considered statistically significant. The analaysis was done by SPSS version 26.

RESULTS

A total of 100 patients with confirmed dengue infection were included in the study. The age of the patients ranged from 18 to 65 years, with a mean age of 34.6 ± 11.2 years and a median age of 33 years. The majority of the patients belonged to the 21–40 years age group (48%), followed by 41–60 years (30%), ≤20 years (12%), and >60 years (10%).

Out of the total participants, 58 (58%) were males and 42 (42%) were females, with a male-to-female ratio of 1.38:1.

Table 1: Age Distribution of Study Participants (n=100)

Age Group (years)	Frequency (n)	Percentage (%)
≤20	12	12
21–40	48	48
41–60	30	30
>60	10	10
Total	100	100

Mean age: 34.6 ± 11.2 years
Median age: 33 years

Table 2: Gender Distribution of Study Participants

Gender	Frequency (n)	Percentage (%)
Male	58	58
Female	42	42
Total	100	100

Laboratory Findings: The mean platelet count among study participants was 72,500 ± 28,400 cells/mm³, with a median platelet count of 68,000 cells/mm³.The mean hematocrit level was 41.8 ± 5.4%, with a median value of 41.2%.

Table 3: Laboratory Parameters of Study Participants

Parameter	Mean ± SD	Median
Platelet count (cells/mm³)	72,500 ± 28,400	68,000
Hematocrit (%)	41.8 ± 5.4	41.2
ALT (IU/L)	64.2 ± 28.6	59
AST (IU/L)	71.4 ± 32.1	65

Ultrasonographic Findings: Ultrasonographic evaluation revealed evidence of plasma leakage in a significant proportion of patients. The most common finding was gallbladder wall thickening (38%), followed by ascites (32%), pleural effusion (28%), and pericardial effusion (6%).

Table 4: Ultrasonographic Findings in Dengue Patients

Ultrasonographic Finding	Frequency (n)	Percentage (%)
Gallbladder wall thickening	38	38
Ascites	32	32
Pleural effusion	28	28
Pericardial effusion	6	6

Correlation Between Ultrasonographic Findings and Platelet Count: Patients with evidence of plasma leakage on ultrasonography had significantly lower platelet counts compared to those without plasma leakage.

Table 5: Platelet Count Comparison Based on Ultrasonographic Plasma Leakage

Plasma Leakage (USG)	Mean Platelet Count ± SD	Median	p-value
Present (n=54)	58,300 ± 18,200	56,000	
Absent (n=46)	89,600 ± 22,100	88,000	<0.001

Statistical test used: Independent t-test.

This difference was statistically significant, indicating that patients with plasma leakage had significantly lower platelet counts.

Correlation Between Ultrasonographic Findings and Hematocrit Levels: Patients with ultrasonographic evidence of plasma leakage demonstrated higher hematocrit values compared to patients without plasma leakage.

Table 6: Hematocrit Levels Based on Plasma Leakage

Plasma Leakage (USG)	Mean Hematocrit ± SD	Median	p-value
Present (n=54)	44.2 ± 4.9	44.0	
Absent (n=46)	39.3 ± 4.1	39.1	<0.001

Statistical test used: Independent t-test.

The difference in hematocrit levels between the two groups was statistically significant, suggesting a strong association between elevated hematocrit levels and ultrasonographic evidence of plasma leakage.

Association Between Ultrasound Findings and Severity Indicators: A statistically significant association was observed between gallbladder wall thickening and thrombocytopenia.

Table 7: Association Between Gallbladder Wall Thickening and Platelet

Gallbladder Wall Thickening	Platelet Count <50,000	Platelet Count ≥50,000	p-value
Present	22	16	
Absent	14	48	0.002

Statistical test used: Chi-square test.

This result indicates that gallbladder wall thickening is significantly associated with severe thrombocytopenia.

DISCUSSION

In the present study, a total of 100 patients with serologically confirmed dengue infection were evaluated. The mean age of the patients was 34.6 ± 11.2 years with a median age of 33 years, and the majority of patients belonged to the 21–40 years age group. Male predominance was observed in our study with 58% males and 42% females.

These findings are comparable with the study conducted by another observational study of 100 dengue patients, where 60% were males and 40% females, indicating a similar male predominance in dengue infection.[10] The higher prevalence among males may be attributed to greater outdoor exposure to mosquito bites and occupational factors in endemic areas. In our study, ultrasonography revealed evidence of plasma leakage in 54% of patients. Among the sonographic findings, gallbladder wall thickening (38%) was the most common abnormality, followed by ascites (32%), pleural effusion (28%), and pericardial effusion (6%). These results are comparable with the study by Narasimhan et al., where ascites was present in 39.8% of patients, gallbladder wall thickening in 27.7%, and pleural effusion in 23.4% of dengue cases.[11]

Similarly, Santhosh et al. reported gallbladder wall thickening in 66.7% of patients, ascites in 64.5%, and pleural effusion in 50%, highlighting these features as the most common ultrasonographic findings in dengue infection.[12] Furthermore, previous studies have described the “plasma leakage triad” consisting of gallbladder wall thickening, ascites, and pleural effusion as characteristic imaging findings in dengue infection.[13] The slightly lower frequency of these findings in our study may be due to differences in disease stage at presentation or variations in disease severity among study populations.In the present study, patients with ultrasonographic evidence of plasma leakage had significantly lower platelet counts (58,300 ± 18,200 cells/mm³; median 56,000) compared to those without plasma leakage (89,600 ± 22,100 cells/mm³; median 88,000) with a statistically significant p-value <0.001.These findings are consistent with previous research demonstrating a strong association between thrombocytopenia and ultrasonographic abnormalities in dengue infection. Narasimhan et al. reported that most ultrasound findings correlated with platelet counts below 40,000 cells/mm³, indicating severe thrombocytopenia in patients with plasma leakage.[14]

Similarly, Santhosh et al. observed that 97.8% of patients with platelet counts below 40,000 cells/mm³ had gallbladder wall thickening, while 86.9% had ascites and 58.6% had pleural effusion.[15] These observations suggest that ultrasonographic evidence of plasma leakage is closely associated with declining platelet counts and may serve as an early indicator of disease severity. In our study, patients with

ultrasonographic evidence of plasma leakage demonstrated higher hematocrit levels (44.2 ± 4.9%; median 44.0) compared to those without plasma leakage (39.3 ± 4.1%; median 39.1) with a statistically significant difference ($p < 0.001$).This finding is consistent with the pathophysiology of dengue infection, where plasma leakage leads to hemoconcentration, resulting in elevated hematocrit levels. However, previous studies have suggested that laboratory parameters alone may not reliably detect early plasma leakage. Michels et al. reported that serial hematocrit measurements failed to consistently identify plasma leakage, whereas ultrasonography was able to detect subclinical plasma leakage in up to 91% of severe dengue cases.[16] Similarly, Tian et al. demonstrated that ultrasonography could identify subclinical plasma leakage even before significant laboratory abnormalities were observed, emphasizing its value in early diagnosis and monitoring.[17] The findings of our study highlight the importance of thoracoabdominal ultrasonography in detecting early plasma leakage in dengue infection. In our study, 54% of patients demonstrated ultrasonographic evidence of plasma leakage, even when clinical signs were not prominent. Previous studies have also emphasized the importance of ultrasonography in the early detection of plasma leakage. A systematic review reported that the prevalence of pleural effusion, ascites, and gallbladder wall thickening in dengue patients was approximately 44.98%, 39.44%, and 61.89% respectively, indicating that these findings are common indicators of disease severity.[18] Furthermore, recent research has demonstrated that gallbladder wall thickening is strongly associated with severe dengue, with reported sensitivity of approximately 88% for predicting disease severity.[19] These findings suggest that ultrasonography plays an important role not only in diagnosing dengue but also in predicting disease progression and identifying patients at risk of severe complications. Our findings indicate that ultrasonographic evidence of plasma leakage is associated with severe thrombocytopenia and hemoconcentration, which are recognized indicators of disease severity. These findings are consistent with several previously published studies that emphasize the role of ultrasonography as a sensitive and non-invasive tool for detecting plasma leakage and predicting severe dengue. Therefore, incorporating routine chest and abdominal ultrasonography in the evaluation of dengue patients may facilitate early detection of plasma leakage, enable better risk stratification, and improve clinical management, particularly in endemic regions where dengue infection is highly prevalent.

CONCLUSION

The present study demonstrated a significant correlation between ultrasonographic findings and laboratory parameters of plasma leakage in dengue patients. Gallbladder wall thickening, ascites, and pleural effusion were the most common radiological features. Patients with these findings showed lower platelet counts and higher hematocrit levels, indicating increased disease severity. Thoracoabdominal ultrasonography proved to be a valuable, non-invasive tool for early detection of plasma leakage. When combined with laboratory parameters, it aids in timely identification of severe dengue and improves clinical decision-making. Overall, its integration into routine evaluation can enhance patient outcomes.

Limitations of the Study

The study had certain limitations, including a relatively small sample size of 100 patients, which may affect generalizability. Being a single-center study, the findings may not represent all populations. Ultrasonography is operator-dependent, which may introduce variability in detecting subtle findings. Only selected laboratory parameters were evaluated, while other biomarkers were not included. Additionally, lack of serial imaging in all patients limited assessment of disease progression. Further multicentric studies with larger samples and serial evaluations are recommended.

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