

A prospective observational study of cardiac involvement during dengue infection at a tertiary care hospital in Sri Lanka

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Abstract

Introduction: Dengue virus infection causes high mortality and morbidity and imposes an economic burden in Sri Lanka. Currently, there is insufficient data on the prevalence and associated factors of cardiac involvement in dengue viral infection in Sri Lanka.

Methodology: A total of 220 patients admitted with dengue viral infection to the National Hospital of Sri Lanka, between July and September 2025, participated in this study. Patients were evaluated for cardiac involvement based on highly sensitive Troponin I positivity and dynamic Electrocardiogram (ECG) changes. Cardiac involvement was stratified into subgroups: Troponin I positivity only, ECG changes only, and both. **Results:** Out of the 220 patients enrolled in the study, 126 (57.27%) were male, and 94 (42.73%) were female. The mean age was 35.02 ($\pm$ 14.84 SD). Troponin I positivity only was seen in 11 (5.00%) patients, and ECG changes only were seen in 28 (12.73%) of patients. 8 (3.63%) had both changes. In total, 47 patients (21.36%) had ECG changes and/or Troponin I positivity. Patients with these changes had significantly higher AST ($p = 0.0287$), lower platelet counts ($p = 0.003$), a higher proportion of diabetes mellitus ($p = 0.041$), and hypertension ($p = 0.0074$). **Conclusions:** In this study, 21.36% of the population had evidence of cardiac involvement, as indicated by ECG changes or Troponin I positivity. Higher AST levels, lower platelet counts, dengue hemorrhagic fever and the presence of comorbidities such as diabetes mellitus and hypertension were recognized as possible associated factors of cardiac involvement by this study.

Key words: Dengue; cardiac; troponin; dengue hemorrhagic fever.

J Infect Dev Ctries 2026; 20(9):1368-1375. doi:10.3855/jidc.22713

(Received 04 December 2025 – Accepted 22 April 2026)

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Introduction

Dengue viral infection is caused by the Dengue Virus (DENV), which has four serotypes: DENV-1, DENV-2, DENV-3, and DENV-4. It is spread via mosquito bites, with *Aedes aegypti* being the primary vector globally and *Aedes albopictus* being a secondary vector in Asia. [1].

According to the World Health Organization (WHO) global dengue surveillance, more than 13 million cases of dengue viral infection have been reported worldwide in 2024 [2]. The global disease burden cost is estimated at around 39 billion US dollars. [3]. Sri Lanka, too, has been significantly impacted, with the country reporting over 45,000 cases in 2024 [4]. Hospitals in Sri Lanka spend an average of \$225.65 per hospitalized dengue patient and \$733.46 per dengue patient admitted to Intensive Care Units [5].

Dengue can have a broad clinical spectrum ranging from asymptomatic infection to dengue fever, dengue hemorrhagic fever and dengue shock syndrome as classified by the World Health Organization (WHO) in 1997 [6]. Cardiac involvement by viruses is a well-described entity, with many causes of viral myocarditis being identified. These include adenoviruses and enteroviruses, such as the coxsackie virus [7]. Dengue

virus remains a recognized but understudied and underdiagnosed cause of myocarditis. Sinus bradycardia, ventricular arrhythmia, transient conduction blocks, non-specific ST and T wave changes, and pericardial effusions are among the manifestations described. [8]. There have been reports of fulminant dengue infections mimicking an acute myocardial infarction [9].

Pathologically, the cardiac involvement in dengue can extend from the myocytes to the conduction system, interstitium and pericardium [9]. The exaggerated immune response can also add to this injury via the leucocyte response and the cytokine storm [10]. Vascular endothelial injury, a pathological hallmark in severe dengue infections, can also be contributory [7].

Despite being a well-recognized complication, cardiac involvement remains underdiagnosed during dengue infection. Challenges in diagnosis may be a reason for this. In most cases, typical symptoms of cardiac involvement may not be seen, and it could be a subclinical process.

Objectives of the study

Primary Objective

- Determine the prevalence of cardiac involvement in

patients admitted with dengue virus infection to a tertiary care hospital in Sri Lanka

Secondary Objectives

- Compare the prevalence of cardiac involvement between patients with dengue fever and dengue hemorrhagic fever, admitted to a tertiary care hospital in Sri Lanka
- Compare the patient characteristics of those with cardiac involvement against those without cardiac involvement amongst patients admitted with dengue virus infection to a tertiary care hospital in Sri Lanka

Methodology

Study Design

This study was an institution-based, prospective, observational study conducted at the National Hospital of Sri Lanka, a single tertiary care hospital, from July to September 2025. The study population was all patients admitted to the medical wards of the National Hospital of Sri Lanka, Colombo, with laboratory-confirmed dengue virus infection according to WHO criteria, with positive NS1 (Non-Structural Protein 1) antigen or Dengue IgM antibodies [11].

Sample size and recruitment

The initial study sample was calculated at 207 patients. A 95% confidence interval was used with a 5% margin of error. The study population of 100,000 was used with a likely sample proportion of 16 % as in similar studies from Asia. [12-14] Patients were recruited by consecutive sampling. All patients

admitted with dengue viral infection to the hospital's medical wards were selected during the study period. From the total of 455 patients admitted with dengue viral infection, 220 patients were enrolled as described in Figure 1.

Inclusion criteria

Patients above 14 years of age suffering from fever with positive NS1 antigen or positive Dengue IgM antibodies.

Exclusion criteria

- Patients with clinical or biochemical evidence of other concurrent infections.
- Patients with anginal symptoms within the last year.
- Patients with acute coronary syndrome within the last year.
- Patients with chronic kidney disease with eGFR < 60 mL/min/1.73 m²
- Patients with documented clinical and echocardiographic evidence of heart failure before admission.

Definitions used in the study

Type of Infection

The type of Dengue Viral infection was classified according to the WHO 1997 classification.

Dengue Fever: Fever with positive NS1 antigen/ Dengue IgM antibodies, having two of the following: Headache, retro-orbital pain, myalgia, arthralgia, Rash, hemorrhagic manifestations and leukopenia

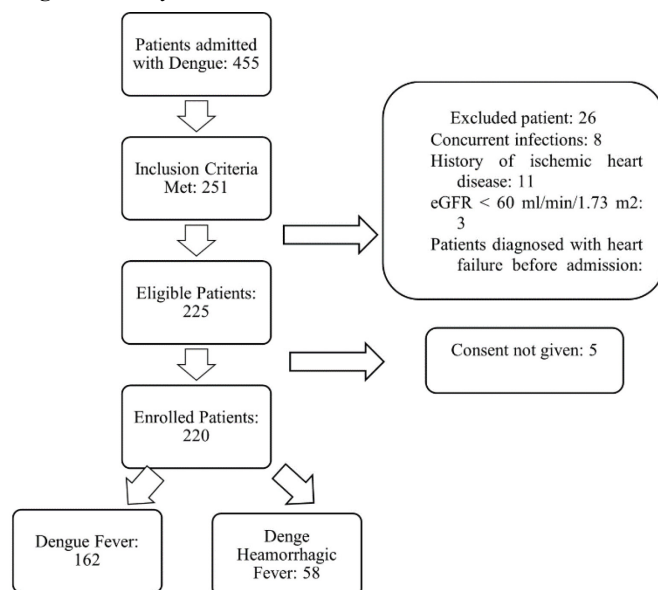
Dengue Hemorrhagic Fever: Patients falling into the above criteria of dengue fever plus

- Thrombocytopenia (100,000 cells per mm³ or less) and
- Evidence of plasma leakage (one of the two criteria below):
 - Rise in the hematocrit greater than or equal to 20%
 - Signs of plasma leakage in a bedside ultrasound scan include the presence of pleural effusion, ascites, or free fluid in the hepatorenal pouch. Gall bladder wall oedema or pericholecystic fluid will not be considered a sign of plasma leakage.

Dengue Shock Syndrome: Patients falling into the above criteria of Dengue Fever plus one of:

- Tachycardia with a weak pulse.
- Narrow pulse pressure (< 20 mmHg).
- Hypotension (Systolic blood pressure less than 90

Figure 1. Study flow chart.



mmHg and/or Diastolic blood pressure less than 60 mmHg).

ECG Changes

ECG showing any one of the following:

- ST-segment elevation of more than 1mm
- ST-segment depression of more than 1mm
- T wave abnormalities (Biphasic, flat or inverted)
- Arrhythmias

Dynamic ECG changes

ECG was performed daily during the admission. ECG changes were recorded as dynamic if the ECG changes (Definition 2) show variability or dynamicity when repeated.

Troponin positivity

Troponin I was measured daily during admission. Highly sensitive troponin titer of more than 0.034 ng/mL for males and more than 0.016 ng/mL for females measured using Abbott i1000, CMIA assay with a functional sensitivity of 0.003 ng/mL. These cut-offs were the 99th percentile for the normal population.

Cardiac involvement

Patients were stratified into three subgroups of possible cardiac involvement: dynamic ECG changes only (Definition 3), troponin positivity only (Definition 4) or both (Definitions 3 and 4)

Statistical analyses

All data were analyzed using IBM SPSS software. Quantitative continuous data were expressed as means

with standard deviation (SD). Qualitative data were expressed as proportions and percentages. Categorical data were compared using Pearson's chi-squared test. Means of quantitative data were compared using an independent sample *t*-test with unequal variance (Welch's *t*-test). Significant differences in the various types of cardiac involvement between dengue fever and dengue hemorrhagic fever were compared using Pearson's chi-squared test. Independent associated factors for cardiac involvement were analyzed according to logistic regression analysis. $p < 0.05$ were considered statistically significant.

Ethical considerations

Ethical clearance was obtained from the Ethical Review Committee of the National Hospital of Sri Lanka, Colombo (Certificate No: AJ/ETH/COM/2025/June dated 2025/07/16). Written informed consent was obtained from all participants who voluntarily enrolled in the study.

Results

A total of 220 patients were analyzed in this study between July to October 2025. They were selected as shown in Figure 1.

Characteristics of the population

Population characteristics are summarized in Table 1. The mean age was 35.02 (± 14.84 SD), ranging from 14 to 79 years. Of the 220 patients, 126 (57.27%) were male, and 94 (42.73%) were female. A history of a dengue infection was present in 59 (26.81%). 162 (73.6%) of the patients had dengue fever, and 58

Table 1. Patient characteristics of the total population, patients with dengue fever and patients with dengue hemorrhagic fever.

Characteristic	Total: 220 (100%)	DF: 162 (73.6%)	DHF: 58 (26.4%)	<i>p</i>
Age (years) ^a	35.02 (± 14.84)	36.20 (± 15.40)	31.72 (± 12.69)	0.03 ^c
Male ^b	126 (57.27%)	93 (57.41%)	33 (56.90%)	0.95 ^d
Female ^b	94 (42.73%)	69 (42.59%)	25 (43.10%)	0.95 ^d
Weight (Kg) ^a	62.03 (± 14.07)	62.51 (± 14.32)	60.69 (± 13.37)	0.38 ^c
Height (cm) ^a	163.69 (± 6.10)	163.68 (± 6.15)	163.70 (± 6.00)	0.98 ^c
BMI (Kg/m ²) ^a	23.07 (± 4.84)	23.24 (± 4.86)	22.60 (± 4.82)	0.39 ^c
Previous Dengue Infection ^b	59 (26.81%)	38 (23.46%)	21 (36.21%)	0.06 ^d
Day of fever admitted ^a	3.05 (± 1.11)	3.10 (± 1.09)	2.93 (± 1.15)	0.34 ^c
AST (U/L) ^a	99.69 (± 84.31)	71.85 (± 51.40)	177.47 (± 107.18)	< 0.01 ^c
ALT (U/L) ^a	85.12 (± 70.28)	66.13 (± 54.41)	138.17 (± 82.02)	< 0.01 ^c
CRP (mg/L) ^a	15.67 (± 16.24)	15.97 (± 17.41)	14.83 (± 12.50)	0.60 ^c
Lowest platelet ($\times 10^3/\text{mm}^3$) ^a	78.80 (± 34.61)	93.53 (± 24.47)	37.66 (± 23.88)	< 0.01 ^c
Positive Troponin I ^b	19 (8.64%)	13 (8.02%)	6 (10.34%)	0.59 ^d
Troponin I Titre (ng/mL) ^a	0.02 (± 0.08)	0.02 (± 0.09)	0.01 (± 0.02)	0.19 ^c
Day of Troponin Positivity ^a	3.79 (± 0.99)	3.76 (± 1.02)	3.88 (± 0.91)	0.42 ^c
Dynamic ECG Changes ^b	36 (16.36%)	16 (9.88%)	20 (34.48%)	< 0.01 ^d
Day of ECG Changes ^a	3.82 (± 1.02)	3.80 (± 1.04)	3.90 (± 0.95)	0.50 ^c
Diabetes Mellitus	24 (10.91%)	19 (11.73%)	5 (8.62%)	0.52 ^d
Hypertension ^b	30 (13.64%)	26 (16.05%)	4 (6.90%)	0.08 ^d
Dyslipidemia ^b	21 (9.55%)	17 (10.49%)	4 (6.90%)	0.42 ^d
Smokers ^b	35 (15.91%)	24 (14.81%)	11 (18.97%)	0.46 ^d
Cardiac Involvement ^b	47 (21.36%)	26 (16.05%)	21 (36.21%)	< 0.01 ^d

(26.4%) had dengue hemorrhagic fever. Cardiac involvement (Troponin I positivity and/or dynamic ECG changes) was noted in 47 patients (21.36%).

Patients with Dengue Hemorrhagic Fever had a significantly lower age than those with dengue fever ($p = 0.032$). They also had a significantly higher AST and ALT ($p < 0.001$), and lower platelet counts ($p < 0.001$).

Patients with cardiac involvement in the form of troponin I positivity or ECG changes

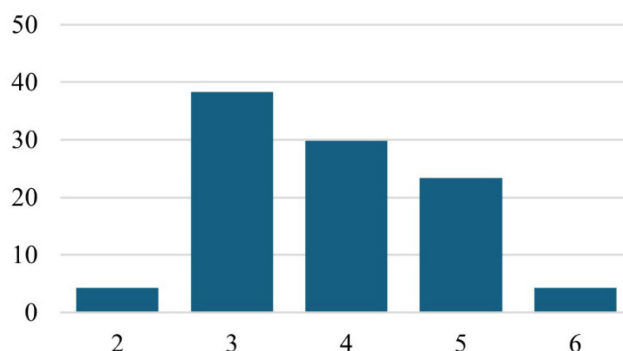
Characteristics of patients with cardiac involvement are summarized in Table 2. The mean age was 39.11 (± 17.00 SD), ranging from 16 to 75 years. Troponin I positivity alone was seen in 11 (5.00%) patients, and ECG changes alone were seen in 28 (12.73%) patients. 8 (3.63%) had both changes. Of the 47 patients with either troponin I positivity or ECG changes, 25 (53.19%) were male, and 22 (46.81%) were female. Comorbidities noted were diabetes mellitus in 9 (19.15%) patients, hypertension in 12 (25.53%) patients and dyslipidemia in 17 (14.89%) patients.

Patients with cardiac involvement had significantly higher AST ($p = 0.0287$) and lower platelet counts ($p =$

0.003) than those without cardiac involvement. The group with cardiac involvement also had a significantly higher proportion of comorbidities, in the form of diabetes mellitus ($p = 0.041$) and hypertension ($p = 0.0074$). Dyslipidemia was significantly higher among patients with troponin positivity ($p = 0.0282$).

Figure 3. Day of dynamic ECG changes (Top) and Troponin I positivity (Bottom) in dengue patients with cardiac involvement.

Day of dynamic ECG changes



Day of Troponin I positivity

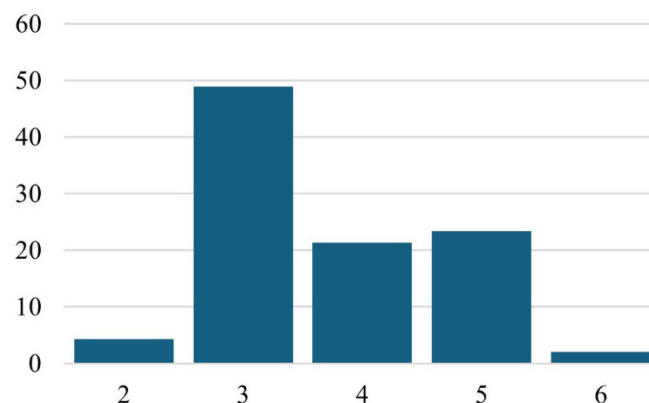


Figure 2. Pattern of cardiac involvement in dengue patients. Percentage of Troponin positivity (Right) and dynamic ECG changes (Left) among dengue patients with cardiac involvement.

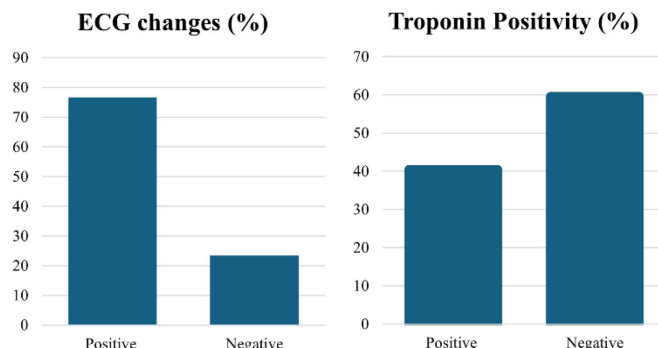


Table 2. Characteristics of patients with and without cardiac involvement among dengue patients.

Characteristic	Cardiac Positive: 47 (21.4%)	Cardiac Negative: 173 (78.6%)	p
Age (years) ^a	39.11 $\pm$ 17.00	33.91 $\pm$ 14.04	0.06 ^c
Male ^b	25 (53.19%)	101 (58.38%)	0.52 ^d
Female ^b	22 (46.81%)	72 (41.62%)	0.52 ^d
Weight (Kg) ^a	63.74 $\pm$ 15.62	61.57 $\pm$ 13.63	0.39 ^c
Height (cm) ^a	164.55 $\pm$ 5.92	163.45 $\pm$ 6.14	0.27 ^c
BMI (Kg/m ²) ^a	23.52 $\pm$ 5.62	22.95 $\pm$ 4.62	0.52 ^c
Previous Dengue Infection ^b	17 (36.17%)	42 (24.28%)	0.10 ^d
Day of fever admitted ^a	3.04 $\pm$ 1.10	3.06 $\pm$ 1.11	0.93 ^c
AST (U/L) ^a	125.57 $\pm$ 91.68	92.66 $\pm$ 81.05	0.03 ^c
ALT (U/L) ^a	102.38 $\pm$ 84.63	80.43 $\pm$ 65.35	0.10 ^c
CRP (mg/L) ^a	14.58 $\pm$ 14.99	15.96 $\pm$ 16.60	0.59 ^c
Lowest platelet ($\times 10^3/\text{mm}^3$) ^a	61.30 $\pm$ 35.70	83.55 $\pm$ 32.82	< 0.01 ^c
Troponin I Titre (ng/mL) ^a	0.06 $\pm$ 0.16	0.00 $\pm$ 0.00	0.03
Diabetes Mellitus	9 (19.15%)	15 (8.67%)	0.04 ^d
Hypertension ^b	12 (25.53%)	18 (10.40%)	0.01 ^d
Dyslipidemia ^b	7 (14.89%)	14 (8.09%)	0.16 ^d
Smokers ^b	9 (19.15%)	26 (15.03%)	0.49 ^d

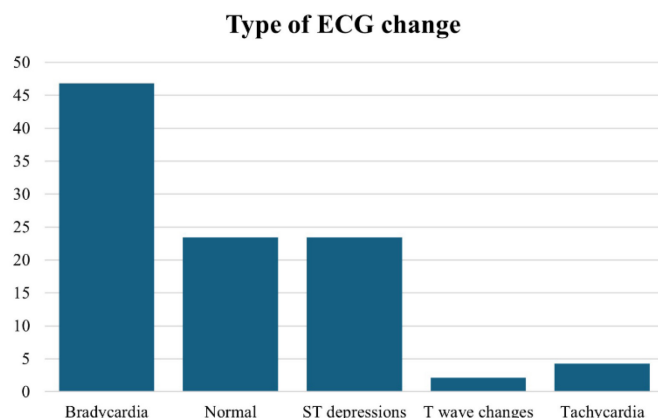
It was important to note that there was no significant difference in the age, sex, BMI, previous dengue infection, or CRP between patients with cardiac involvement and those without.

Troponin positivity was observed in 19 patients, representing 40.4% of the patients with cardiac involvement. Dynamic ECG changes were the most common type of cardiac involvement seen in 36 patients, which was 76.6% of patients with cardiac involvement, as illustrated in Figure 2. Both Troponin positivity and ECG changes were noted most frequently on day 3 of fever, as shown in Figure 3.

The most common ECG change was sinus bradycardia, as shown in Figure 4. There was also a notable number of patients with ST depressions, while only a minority had T wave changes and tachycardia. ST elevations were not noted in any patient.

As compared to patients with dengue fever, patients with dengue hemorrhagic fever had a significantly higher percentage of cardiac involvement ($p = 0.001$) and ECG changes ($p < 0.001$). Although the percentage of troponin positivity was higher among patients with dengue hemorrhagic fever, the difference was not statistically significant ($p = 0.589$). This is illustrated in Figure 5.

Figure 4. Type of ECG changes amongst dengue patients with cardiac involvement.



Independent factors associated with cardiac involvement were evaluated using logistic regression, as summarized in Table 3.

Eight variables were used, with 58 events (7.25 events per variable). Goodness-of-fit was acceptable: Hosmer-Lemeshow chi-square = 3.16, degree of freedom = 8, $p = 0.924$. Cardiac involvement was significantly associated with some variables: comorbidities, with an odds ratio of 2.94 (95% CI 1.52–5.88; $p < 0.01$). Odds ratio for dengue hemorrhagic fever was 2.97 with a 95% confidence interval of 1.50 – 5.86 ($p < 0.01$). Odds ratio for AST more than 100 U/L was 2.56 with 95% confidence interval of 1.33 – 5.01 ($p < 0.01$). The odds ratio for patients with platelet counts less than 50,000/mm³ was 3.74, with a 95% confidence interval of 1.88–7.42 ($p < 0.01$).

No mortality was reported among patients in this study. Patients in all subgroups (Troponin-positive only, ECG changes only, or both) were discharged home after successful recovery from the infection. None of these patients required Intensive Care Unit (ICU) admissions. The mean duration of hospital stay was 6.13 days and was not significantly different from the duration of hospital stay amongst patients without troponin or ECG changes ($p = 0.96$).

Figure 5. Comparison of different patterns of cardiac involvement between dengue fever and dengue haemorrhagic fever using the independent-sample proportion test. DF: Dengue Fever; DHF: Dengue Hemorrhagic Fever.

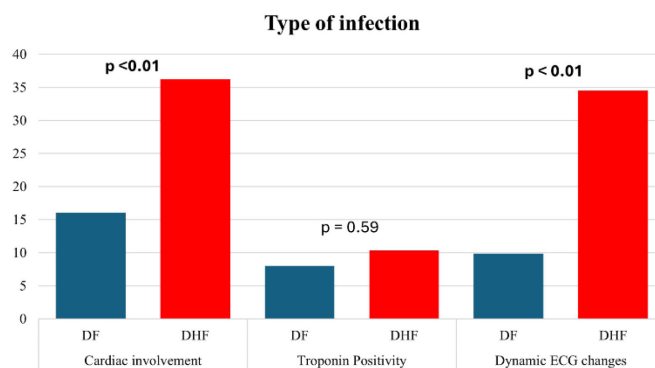


Table 3. Independent associated factors for cardiac involvement in dengue according to logistic regression analysis.

	Odds Ratio	Confidence Interval	<i>p</i>
Male	0.81	0.42 – 1.54	0.52
Presence of comorbidities	2.94	1.52 – 5.88	< 0.01
DHF	2.97	1.5 – 5.86	< 0.01
Day of Fever < 3	0.96	0.48 – 1.92	0.91
Age > 40	0.78	0.4 – 1.53	0.48
AST > 100 U/L	2.56	1.33 – 5.01	< 0.01
Lowest Platelet $\leq 50 \times 10^3/\text{mm}^3$	3.74	1.88 – 7.42	< 0.01
CRP > 10 mg/L	0.97	0.51 – 1.85	1
BMI > 25 kg/m ²	1.04	0.52 – 2.1	1

Discussion

Prevalence of cardiac involvement

This study reveals that 21.36% of patients admitted with dengue viral infection had cardiac involvement in the form of ECG changes only, cardiac biomarker positivity (specifically Troponin I) only, or both. Troponin I positivity only was seen in 11 (5.00%) patients, and ECG changes only were seen in 28 (12.73%) of patients. 8 (3.63%) had both changes. Among patients with cardiac involvement, the mean Troponin I titre was 0.06 ng/mL, which was about three times the 99th percentile for the normal population.

It is, however, important to note that these changes only suggest a possibility of cardiac involvement and are not confirmatory of myocarditis. Echocardiographic correlation was not carried out in this study. Further, Troponin I positivity and ECG changes can occur in many other conditions, including acute coronary syndrome, pericarditis, heart failure, hypotension, cardiac dysrhythmias, pulmonary embolism, renal impairment, and trauma. These conditions were excluded as possible confounders in the study.

The prevalence of cardiac involvement is similar to other studies from Asia. A study in Thailand that examined cardiac involvement using echocardiography reported a prevalence of 22.2% [13]. Studies from the neighboring country, India, have shown prevalences in the range of 19.2% to 26.92% [15-16]. A study from Bangladesh has reported a prevalence of 22.0% [17]. Pooled data from a systematic analysis and meta-analysis show a prevalence of 21.0 % (95% CI, 9 – 38%). Data from meta-analysis [18] Shows a higher prevalence of cardiac involvement in Asia (15.2%) compared to countries like Latin America (3.6%). This could be due to the endemicity of dengue viral infection in certain Asian countries, as repeated infections lead to more severe manifestations due to an augmented immune response. Variations in dengue virus strain across geographic areas could also contribute to this difference.

However, cardiac biomarker positivity was lower in our study (8.64%) as compared to studies from neighboring countries like India, which have shown a higher positivity rate of around 13.33% in some studies. [8] and up to 26.7%[14] In others. ECG changes were also more prevalent in neighboring countries, ranging from 8.2% to 48.14% [19–21].

It was interesting to note that the clinical outcomes concerning mortality, length of hospital stay, and need for ICU admissions were not higher amongst those with cardiac involvement. None of these patients developed major hemodynamic instability or required specific

treatment for cardiac involvement. Most changes were transient and resolved before discharge. All patients recovered well and were discharged home without the need for ICU admissions.

Factors associated with cardiac involvement

Factors that were associated with a higher probability of cardiac involvement were higher AST levels, lower platelets, presence of comorbidities and patients having dengue hemorrhagic fever, as shown in Table 3.

Rise in AST and ALT in dengue is due to liver involvement. This may be due to both direct viral invasion as well as immune-mediated damage to the liver. [22]. The disproportionate rise in AST as compared to ALT in dengue is possibly due to non-hepatic sources of AST, such as cardiac and skeletal muscle damage. [23]. This was reflected in our study as well, where AST was significantly higher in patients with cardiac involvement as compared to those without. This was not seen with ALT. Further, higher transaminase levels are seen in patients with more severe disease. [23].

Patients with dengue hemorrhagic fever (DHF) had a significantly higher cardiac involvement as compared to patients with dengue fever (DF). This can be explained by the hemodynamic changes due to vascular endothelial injury and fluid leakage that occurs in DHF [7]. These patients also have an exaggerated immune response that damages host tissue, which can involve the cardiac tissue as well. [10].

The higher probability of cardiac involvement due to the presence of comorbidities is probably due to underlying atherosclerosis that makes the cardiac tissues more vulnerable to injury by the above mechanisms, mainly the hemodynamic changes.

Pattern of cardiac involvement

Several studies, including ours, show that the commonest ECG change in dengue is sinus bradycardia. This may be due to a transient sinus node dysfunction [24]. This study shows that ECG changes and Troponin I positivity commonly occurred on the third day, with most occurrences between 3-5 days, which is comparable with other studies [15,25]. This time coincides with fluid leakage in dengue, further supporting its role in causing hemodynamic instabilities and cardiac damage.

Previous studies have shown that cardiac involvement in dengue is transient and self-limited. [24,26]. Good supportive care with careful fluid management is the key to recovery. Improper fluid

management can lead to iatrogenic fluid overload and high morbidity.

Limitations

The major limitation in this study was the fact that it was done only in a single center in Sri Lanka. Therefore, the findings may not be generalized to all dengue patients. Patients with suspected cardiac involvement did not undergo echocardiographic correlation, which could have led to a diagnostic misclassification and potential overestimation of the prevalence of cardiac involvement. There are potential residual confounding factors that could have led to troponin positivity or ECG changes, which were not included with imaging. Consecutive sampling could have led to a sample bias. A larger, multicenter study with random sampling would have strengthened the study. Another limitation was the lack of follow-up of these patients for a longer period to look for any persistence or recurrence of cardiac involvement.

Conclusions

In this study, 21.36% of the population had evidence of cardiac involvement in the form of ECG changes or Troponin I positivity. Troponin I positivity only was seen in 11 (5.00%) patients, and ECG changes only were seen in 28 (12.73%) of patients. 8 (3.63%) had both changes. Most of these changes were transient and self-limiting. The majority of these changes occurred during the third to fifth day of fever. Sinus bradycardia was the most common ECG change that was noted. Higher AST levels, lower platelet counts, dengue haemorrhagic fever and the presence of comorbidities such as diabetes mellitus and hypertension were recognised as possible associated factors of cardiac involvement by this study.

Acknowledgements

This work was supported by a research grant awarded by the Ceylon College of Physicians, Sri Lanka.

Authors' contributions

L.S. performed the design, data analysis, and manuscript writing. H.K. and N.D. contributed to the final version and supervised the project.

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Conflict of interest

No conflict of interest is declared.

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