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Original Article

Left ventricular myocardial performance in patients with dengue hemorrhagic fever and thrombocytopenia as assessed by two-dimensional speckle tracking echocardiography

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ABSTRACT

Objectives: We obtained longitudinal, radial and circumferential strains in patients with dengue hemorrhagic fever (DhF) and thrombocytopenia using two-dimensional (2D) speckle tracking echocardiography to analyze left ventricular (LV) myocardial performance.

Methods: In this prospective study, 2D echocardiographic images of the left ventricle in the four-, three- and two-chamber views and parasternal short-axis views at the basal, mid and apical levels were obtained in 40 subjects: 20 patients (23 ± 8 years, 12 male) with DhF and thrombocytopenia and 20 healthy controls (23 ± 5 years, 11 male). Of the 20 patients, imaging was performed again in 19 at discharge after a hospital stay of 8 ± 1 days. Longitudinal, circumferential and radial strains were quantified and compared in an 18-segment model using a novel speckle tracking system.

Results: Left ventricular global ejection fraction was reduced in patients with DhF at presentation as compared with controls ($51.25 \pm 0.96\%$ vs. $59.32 \pm 1.26\%$; $p = 0.032$). Peak longitudinal strain in patients with DhF was significantly attenuated in the subendocardial region compared with normal controls ($p < 0.001$). A significant increase in circumferential strain for patients with DhF was evident only in the subepicardial region ($p = 0.009$). Patients with DhF showed significantly higher radial strain than controls ($p < 0.001$). On multivariate analysis, subendocardial longitudinal strain independently predicted the duration of hospital stay in patients with DhF.

Conclusion: Assessment of speckle tracking echocardiography-derived LV mechanics helps in understanding myocardial mechanics in patients with DhF and thrombocytopenia. Identification of reduced LV longitudinal strain helps in understanding the mechanism of reduced LV myocardial performance seen in patients with DhF.

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1. Introduction

Dengue hemorrhagic fever (DhF) is one of the most common tropical diseases worldwide and globally associated with significant morbidity and mortality.¹ It is caused by a flavivirus transmitted to humans by infected *Aedes aegypti* mosquitoes.² Cardiac involvement in DhF has been reported^{3,4} but not studied adequately. The various cardiac conditions reported in patients with DhF are atrial fibrillation,⁵ heart block and left ventricular (LV) systolic and diastolic impairment.⁴ Left ventricular dysfunction has been reported to be transient as assessed by LV ejection fraction.⁶ For assessment of LV myocardial performance, ejection fraction, tissue Doppler imaging, Doppler strain and two-dimensional (2D) strain have been used widely.^{7,8} Subclinical changes in LV function can be identified by quantifying myocardial strain, a dimensionless measurement of deformation expressed as a fractional or percentage change from an object's original dimension. Two-dimensional speckle tracking echocardiography has recently emerged as a novel technique for rapid offline and bedside analysis of LV strains in the longitudinal, radial and circumferential directions.^{9–12} The modality is used to analyze myocardial motion as it tracks natural acoustic reflections and interference patterns of 2D echocardiographic images, and has been validated with measurements obtained by sonomicrometry and magnetic resonance imaging. Assessment of myocardial mechanics affecting LV function in patients with DhF and thrombocytopenia has not been studied in detail. The aim of this study was to assess the ability of using subtle differences in LV longitudinal, radial and circumferential strains to characterize features of LV dysfunction in patients with DhF and thrombocytopenia.

2. Methods

2.1. Study population

This was a prospective study conducted at a tertiary care hospital in central India from June to December 2011. The study population comprised 20 consecutive patients (23 ± 8 years, 12 male) seropositive for DhF presenting with thrombocytopenia (platelet count: $45,000 \pm 6000$ per μL) and 20 age- and sex-matched healthy volunteers from the community who acted as controls (23 ± 5 years, 11 male). Echocardiography was performed both at presentation and discharge after a hospital stay of 8 ± 1 days. One patient died in the hospital. Patients with established coronary artery disease with evidence of regional or global wall motion abnormalities, atrial fibrillation, valvular heart disease, diabetes mellitus, chronic obstructive airway disease and hypertrophic cardiomyopathy were excluded. Written informed consent was obtained from the patients and controls, and the study was approved by the institutional review board. The flow of participants through all stages of the study is depicted in Fig. 1. Patients were treated with intravenous fluids, platelet concentrate infusions according to platelet levels and supportive therapy. Patients were considered for discharge when their condition was

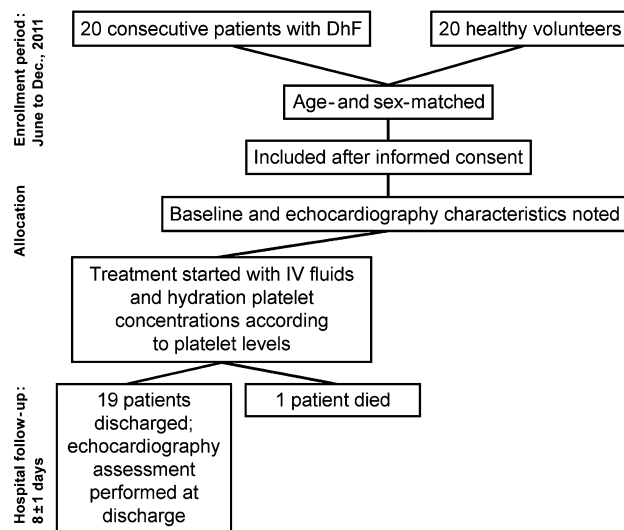


Fig. 1 – CONSORT diagram showing the flow of participants through each stage of the study. DhF: dengue hemorrhagic fever, IV: intravenous.

stable, they were afebrile and platelet count was more than $150,000/\mu\text{L}$.

2.2. Echocardiography

A comprehensive transthoracic echocardiography examination was performed for all patients with DhF and thrombocytopenia at presentation and discharge (excluding the one patient who died) and members of the control group. Commercially available ultrasound transducer and equipment (S4-2 probe, HD7 ultrasound system, Philips Healthcare) were used. The same experienced operator performed all acquisitions with the patients in the left lateral position. Basic measurements included LV wall thickness by M-mode, LV diameter by 2D echocardiography and mitral inflow velocities by tissue Doppler imaging with settings per recommendations by the American Society of Echocardiography.¹³ Left ventricular volumes and LV ejection fraction were measured using the biplane method (modified Simpson's rule) as recommended by the American Society of Echocardiography.¹⁴ To determine the timing of cardiac events, mitral inflow and LV outflow were recorded using pulsed Doppler echocardiography. Two-dimensional echocardiographic images of the LV in the four-, three- and two-chamber views and parasternal short-axis views at the basal, mid and apical levels were acquired with same ultrasound machine. Three consecutive cardiac cycle loops were recorded at end expiration. The frame rate was kept between 70 and 100 Hz.¹⁵ Longitudinal, circumferential and radial strains were quantified in an 18-segment model using a novel speckle tracking system (2D Cardiac Performance Analysis, TomTec Imaging Systems, Munich, Germany). The system is a speckle tracking-based tool that can analyze 2D data from various ultrasound machines and is an extension of velocity vector imaging software, which has been previously validated with sonomicrometry^{8,9} and magnetic resonance imaging.^{10,11} The

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