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Echocardiographic Evidence of Right Ventricular Dysfunction in Patients with Dilated Cardiomyopathy

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ABSTRACT

Background: In dilated cardiomyopathy (DCM), clinical attention primarily focuses on left ventricular (LV) functions, often neglecting the right ventricle (RV). This study aimed to describe the demographics of the patients with a focus on echocardiographic parameters and prevalence of RV dysfunction (RVD) in DCM.

Methods: This cross-sectional descriptive study was conducted in the Cardiology Unit, Department of Internal Medicine, Nepal Manipal Teaching Hospital, Pokhara, from September 2024 to August 2025. Patients who had echocardiographic evidence of DCM were evaluated for RVD based on four criteria: tricuspid annular plane systolic excursion (TAPSE), RV peak systolic velocity (RVS'), myocardial performance index (MPI) also known as TEI index, and RV ejection fraction (RVEF). Data were collected in a structured proforma, and statistical analyses were carried out. This study was approved by institutional research committee.

Results: Of 100 patients (53 males, 47 females; mean age 58.59±11.98 years), mean TAPSE was 19.32±4.08 mm, RVS' 11.92 ±1.96 cm/s, TEI index 0.49 ±0.097, and RVEF 44.7%±8.04. RVD was diagnosed in 44 patients by at least one criterion. Individually, RVD was identified in 29 patients by TAPSE, 29 patients by TEI criteria, 16 patients by RVS', and 40 by RVEF. TAPSE and TEI index showed identical classification results (p = 1.000, two-sided exact test), with no statistically significant difference in their performance.

Conclusions: RVEF identified the highest proportion of RVD (40%), supporting its role as a comprehensive reference standard for global RV systolic function. TAPSE exhibited higher sensitivity and specificity than TEI for detection of right ventricular dysfunction.

Keywords: Echocardiography; dilated cardiomyopathy; Nepal; right ventricular function; TAPSE; TEI index.

INTRODUCTION

Dilated cardiomyopathy (DCM) is myocardial disease characterized by left or biventricular systolic impairment, and left ventricle (LV) dilatation, absent coronary artery disease or valvular heart disease.[1] Traditionally, clinical and research focus has centered on LV morphology and function, with limited attention to right ventricular (RV) involvement. However, RV dysfunction (RVD) commonly accompanies advanced LV systolic dysfunction and significantly worsens outcomes in DCM.[2,3] In DCM patients with heart failure (HF), clinicians mostly focus on LV function, often neglecting the RV.[4,5]

The prevalence of RVD in DCM varies widely (20 to 65%) across recent studies.[6-8] Pathogenesis involves several mechanisms, primarily complex inter-ventricular relationship.[4] LV systo-diastolic impairment, increased LV filling pressure, and relevant mitral regurgitation (MR) leading to type 2 pulmonary hypertension, chronic RV pressure overload, dilation and dysfunction.[9,10] Guideline-directed medical therapy (GDMT), including loop diuretics for fluid optimization and neurohormonal antagonism, often improves RV function.[11]

Trans-thoracic echocardiography (TTE) remains first-line modality for RV assessment due to its availability and cost-efficiency.[12] This study aimed to

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study the demographics of the DCM patients, their echocardiographic parameters, prevalence of RVD, with particular focus on RV involvement.

METHODS

A cross-sectional study was conducted in the Cardiology Unit under Department of Medicine at Manipal Teaching Hospital, Pokhara, Nepal from September 2024 till August 2025. Written informed consent was obtained from all the patients. A total of 100 patients presenting to medicine/cardiac OPD or Emergency Department of Nepal Manipal Teaching Hospital and diagnosed as DCM by echocardiography performed by certified cardiologists were included in the study. Patients with diagnosed ischemic heart disease, valvular heart disease were excluded from the study.

Transthoracic echocardiograms were conducted on SIEMENS ACUSON SC2000. Echocardiographic measurements were made following recommended steps suggested by guidelines.[12,13] DCM defined as LVEF≤40% and left ventricular end-diastolic diameter ≥55mm. Tricuspid annular plane systolic excursion was measured by M-mode, two-dimensional echocardiography guidance at the lateral tricuspid annulus, as the maximal systolic excursion. Tissue Doppler imaging at the tricuspid annular free wall allowed the assessment of RV peak systolic velocity (S') and myocardial performance index/TEI index was calculated by TDI Doppler study. RV and LV ejection fraction (LVEF) measured according to the Teichholz method which is a simplified way to estimate LVEF using Motion(M)-mode echocardiography. It relies on measuring the left ventricular internal diameter in diastole (LVIDd) and systole (LVIDs) from the parasternal long-axis view, then applying a geometric formula to approximate LVEF.

Information regarding presenting patient demographics, vital signs at presentation and presenting signs and symptoms was collected. The vital signs included blood pressure (BP), pulse rate, respiratory rate and body temperature. The laboratory values were also collected. A predesigned proforma was utilized for data collection. The data thus collected were entered in Microsoft Excel sheet and exported statistical package for the social sciences (SPSS) software version 21.0 to for analysis.

Quantitative variables were presented as arithmetic mean with standard deviation (SD), whereas qualitative variables were expressed as percentages. RV dysfunction based on TAPSE, S' and TEI Index and RVEF were calculated as a percentage and their sensitivity, specificity for the detection of RVD was compared. For all tests, $p < 0.05$ was considered significant. The proposal of this study is approved by the Institutional Review Committee of Nepal Manipal Teaching Hospital (MCOMS/IRC/599/GA). Written informed consent was obtained from all the participants.

RESULTS

A total of 100 patients with dilated cardiomyopathy who had presented to Nepal Manipal Teaching Hospital during the one-year study period between September 2024 and August 2025 were included. There were 53 males and 47 females, with a mean age of 58.59±11.98 years. Other baseline characteristics like systolic/diastolic BP, pulse rate, LVEF, LV size were compared along with comorbidities and clinical findings as shown in Table 1.

Table 1. Baseline characteristics of patients with DCM (n = 100).

Characteristic		Range/Frequency	Mean (SD)
Age (years)		29-80	58.59±11.98
Sex	Male	53	
	Female	47	
Systolic BP (mmHg)		86-170	113.32±24.99
Diastolic BP (mmHg)		50-110	70.48±14.78
Pulse (bpm)		50-121	75.43±18.88
LVEF (%)		15-40	31.55±7.39
LVID (mm)		56-73	60.59±4.57
Comorbidities	Hypertension	14	
	Dyslipidemia	34	
	Diabetes Mellitus-2	26	
	Smoking	24	
	Obesity	8	
Clinical findings	Raised JVP	21	
	Edema	14	
	Basal crepitations:	14	

RVD was diagnosed using parameters such as TAPSE <16 mm, RV S' <9.5 cm/s, TEI/TDI >0.55, and RVEF <44%. Regarding RV function parameters, TAPSE ranged from 10 to 27 mm (mean 19.32 mm ±4.08), RV S' ranged from 7 to 16 cm/s (mean 11.92 cm/s ±1.96), TEI TDI ranged from 0.24 to 0.80 (mean 0.49 ±0.097), and RVEF ranged from 30% to 55% (mean 44.7% ± 8.04). By individual parameters, 29 patients met TAPSE criteria, 29 patients met TEI TDI criteria, 16 patients met RV S' criteria, and 40 patients met RVEF criteria. Of these, 14 patients had RVD by only one criterion, 7 patients by two matched criteria, another 12 by three matched criteria, and 11 patients fulfilled all four criteria. There were 44 patients who met RVD criteria using either of four criteria as shown in table 2.

Table 2. Prevalence of RVD by echocardiographic parameters (n = 100).

Parameters	RVD (+)	RVD (-)
TEI/Tdi	29	71
TAPSE	29	71
RV S'	16	84
RVEF	40	60
One parameter (any of above)	44	66

Table 3. Contingency table for TAPSE, TEI/TDI and RVEF.

	TAPSE Vs RVEF	TEI TDI Vs RVEF	TAPSE Vs TEI TDI
True Positive (a)	27	25	21
False Positive (b)	2	4	8
False Negative(c)	13	15	8
True Negative (d)	58	56	63
Sensitivity (%)	67.5	62.5	72.4
Specificity (%)	96.7	93.3	88.7
PPV (%)	93.1	86.2	72.4
NPV (%)	81.7	78.9	88.7
Accuracy (%)	85	81	84
Kappa	-	-	0.61

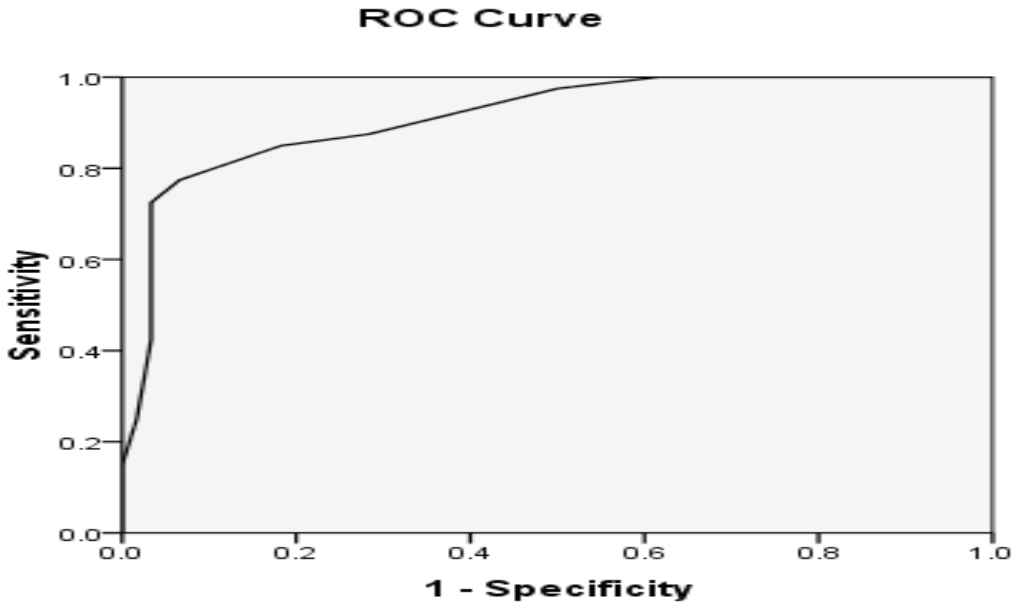

Figure 1. ROC curves for detection of RVD with DCM (TAPSE vs RVEF: AUC = 0.9140).

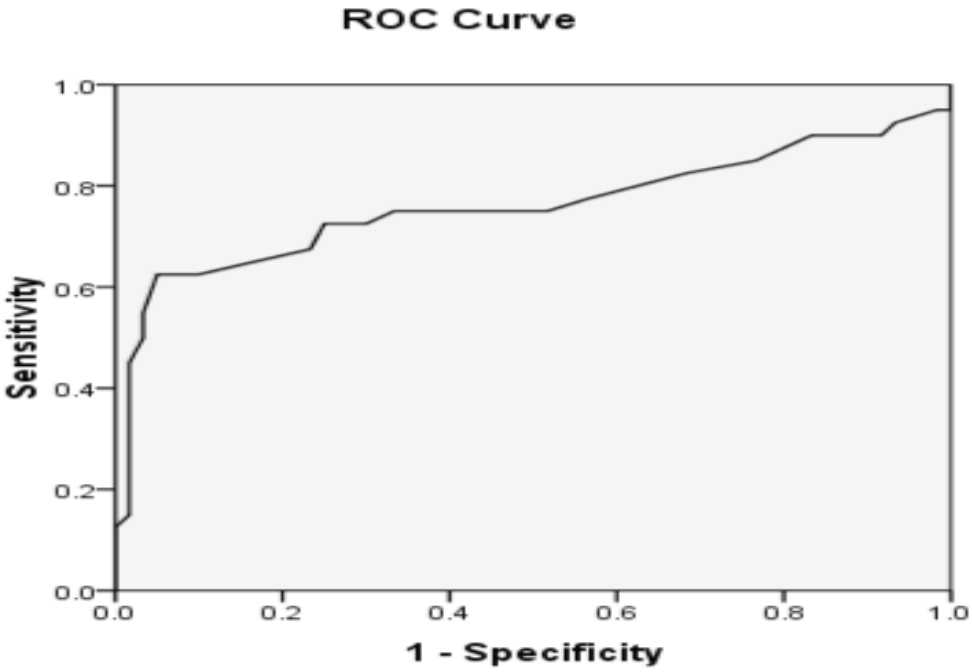

Figure 2. ROC curves for detection of RVD with DCM (TEI TDI vs RVEF: AUC = 0.760).

Using RVEF as the reference standard, the diagnostic accuracy of TAPSE and TEI TDI for detecting RVD was as follows:

Table 4. Summary of diagnostic performance of TAPSE and TEI TDI.

Parameter	Sensitivity (%)	Specificity (%)	AUC	Kappa	McNemar p-value	Discordance Direction
TAPSE	67.5	96.6	0.914	0.672	0.007	(more false negatives)
TEI TDI	62.5	93.3	0.760	0.585	0.019	(more false negatives)
RV S'	37.5	98.3	0.810	0.398	0.000	(more false negatives)

When compared with RVEF as the reference standard, TAPSE demonstrated a sensitivity of 67.5% and a specificity of 96.7%, with a positive predictive value of 93.1% and a negative predictive value of 81.7% as shown in table 3. TEI TDI showed a sensitivity of 62.5% and specificity of 93.3%, with a positive predictive value of 86.2% and a negative predictive value of 78.9% as shown in table 3. Overall, TAPSE exhibited higher sensitivity, specificity, and area under the ROC curve than TEI TDI as shown in figure 1 and 2, indicating superior discriminative performance for detection of right ventricular dysfunction. Agreement analysis further supported these findings, with TAPSE showing good agreement with RVEF (κ = 0.672), whereas TEI TDI demonstrated moderate agreement (κ = 0.585). McNemar testing revealed statistically significant discordance between both parameters and RVEF, primarily due to false-negative classifications as shown in table 4.

TAPSE and TEI TDI indicated good agreement when compared directly as shown by Kappa=0.611 and Mc Nemar p-value =1.000, with equal numbers of discordant pairs (b = 8, c = 8) as shown in table 3 and 4.

Correlation analysis was performed to assess the relationship between right ventricular dysfunction (RVD) and cardiac parameters. There was no significant correlation between RVD and left ventricular internal diameter (LVID)

(r = -0.052, p = 0.609), or between RVD and ejection fraction (EF) (r = -0.059, p = 0.559), indicating that the presence of RVD was not associated with LVID or EF in this cohort.

The association between clinical signs and right ventricular dysfunction (RVD) was evaluated. Raised jugular venous pressure (JVP) was present in 21 patients, 15 of whom had RVD. Chi-square analysis demonstrated a significant association between raised JVP and RVD (x^2 = 9.45, p = 0.002). Continuity correction (x^2 = 7.98, p = 0.005), likelihood ratio (x^2 = 9.46, p = 0.002), and linear-by-linear association (x^2 = 9.36, p = 0.002) all confirmed the significance of this association.

Similarly, edema was present in 14 patients, 10 of whom had RVD. The association between edema and RVD was highly significant (x^2 = 22.49, p < 0.001), with continuity correction (x^2 = 19.80, p < 0.001), likelihood ratio (x^2 = 27.53, p < 0.001), and linear-by-linear association (x^2 = 22.25, p < 0.001) also demonstrating significance.

DISCUSSION

Right ventricular dysfunction (RVD) is an important yet frequently under-recognized component of dilated cardiomyopathy (DCM). In the present study, RVD was identified in 44% of patients using at least one echocardiographic parameter, highlighting the substantial burden of RV involvement in this population. In our cohort, TAPSE identified RVD in 29% of patients and demonstrated a sensitivity of 67.5% and specificity of 96.7% when compared with RVEF, with a high positive predictive value (93.1%). The prognostic role of TAPSE in patients with non-ischemic DCM has been extensively studied.[7] A study in German patients with DCM and preserved RV function had significantly higher survival rates compared to those with RV systolic dysfunction defined by a TAPSE < 15 mm, irrespective of the degree of LV dysfunction.[7] Major adverse cardiac event-free survival rates at 1 and 2 years were 64% and 55%, respectively, compared with the patients which had preserved RV function, whose survival rates were 87% and 79%, respectively.[7] A reduced TAPSE appeared as an independent predictor for major cardiac events.[7] An Italian study demonstrated that in DCM patients a TAPSE 14 mm emerged as an independent predictor of death or urgent cardiac transplantation.[14] Likewise, a study from Japan found TAPSE to be independently associated with the primary composite outcome consisting of left ventricular assist device (LVAD) implantation or all-cause death in patients with non-ischemic DCM.[15] The prognostic role of the RV has also been assessed in acute HF patients with different EF ranges in a Swiss study where it was demonstrated that an increase in TAPSE secondary to decongestive HF treatment was associated with a lower incidence of the combined outcome, irrespective of the LVEF.[16] The prognostic significance of RV systolic dysfunction defined as TAPSE < 17 mm was also confirmed in a large study from Poland with 545 DCM patients, but not independent of LVEF.[17] In contrast, another Japanese study did not find any association between TAPSE reduction and the outcome consisting of LVAD implantation or cardiac death within one year when compared to other RV functional parameters in DCM patients with advanced HF.[18]

RVEF identified the highest proportion of patients with RVD in our study (40%), supporting its role as a comprehensive reference standard for global RV systolic function. This observation is consistent with findings from the French study which demonstrated that RVEF had the highest accuracy for predicting survival in heart failure patients, and that combining RVEF with S′ wave velocity provided incremental prognostic value.[19] Similarly, a Canadian study demonstrated an independent association between S′ wave velocity and adverse outcomes in heart failure.[20] However, in our cohort, RVS' identified fewer patients with RVD (16%), suggesting limited sensitivity for detecting early or subtle dysfunction, particularly in the context of complex right ventricular geometry; this observation is in line with a small retrospective study in patients with advanced DCM, which failed to demonstrate a significant association between reduced S′ wave velocity and clinical outcomes.[18]

The right ventricular myocardial performance index (RV MPI or TEI index), especially when derived using tissue Doppler imaging (TEI TDI), provides a combined assessment of systolic and diastolic RV function. In the present study, TEI TDI identified RVD in 29% of patients and demonstrated a sensitivity of 62.5% and specificity of 93.3% compared with RVEF, with a positive predictive value of 86.2%. However, its overall diagnostic performance was inferior to TAPSE, with a lower AUC (0.760) and only moderate agreement with RVEF (κ = 0.585). The prognostic role of RV MPI has been studied in different cohorts with HF with reduced ejection fraction (HFrEF). In an Italian study by Vizzardi et al. on patients with moderate HF, an RV MPI > 0.38 along with a reduced TAPSE predicted the prognosis at 5-year follow-up.[21] An American study by Field et al. demonstrated that RV dysfunction, defined as an increased RV MPI value, was associated with adverse outcomes in a population of advanced HF

patients referred to cardiac resynchronization therapy (CRT).[22] Each 0.1-unit increase in RV MPI was associated with a 16% increased risk of MACEs (defined as death of all-cause, cardiac transplantation, or ventricular assist device placement).[22] However, TEI index may be influenced by loading conditions and geometry of the RV.[23] It is generally considered reliable when used alongside other parameters like TAPSE. It may also be affected by heart rate and rhythm abnormalities.[23,24] RV involvement was also associated with increased mortality in a global congestive heart failure (G-CHF) study which enrolled 17321 patients with HF from across 40 high-, middle- and low- income countries.[25] A previous Nepali study demonstrated 14.5% of adult patients presenting with HF were patients with DCM.[26] Contrastingly, DCM is reported in only 1.37% of the pediatric population in a study conducted in Kathmandu.[27] This focuses on the burden of disease in adult population in our part of the world. To the best of our knowledge, no studies have specifically addressed the RV involvement in these groups of patients. Given the limitations of echocardiography in RV imaging due to its complex geometry, future studies should explore 3D echo or cardiac MRI for more accurate evaluation.

CONCLUSIONS

RV involvement is observed in significant proportion of patients with DCM. Right ventricular ejection fraction (RVEF) identified the highest proportion of patients with RVD in our study (40%), supporting its role as a comprehensive reference standard for global RV systolic function. Though TAPSE exhibited higher sensitivity and specificity than TEI TDI indicating superior discriminative performance for detection of right ventricular dysfunction. However, TAPSE and TEI TDI show substantial agreement in detecting RVD and both measures can be considered complementary and consistent with no evidence that one is statistically better than the other.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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