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SHORT COMMUNICATION

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Emergency physician use of tissue Doppler bedside echocardiography in detecting diastolic dysfunction: an exploratory study

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Abstract

Introduction: This study evaluates the agreement between emergency physician (EP) assessment of diastolic dysfunction (DD) by a simplified approach using average peak mitral excursion velocity (e'_A) and an independent cardiologist's diagnosis of DD by estimating left atrial (LA) pressure using American Society of Echocardiography (ASE) guidelines.

Methods: This was a secondary analysis of 48 limited bedside echocardiograms (LBE) performed as a part of a research study of patients presenting to the Emergency Department (ED) with elevated blood pressure but without decompensated heart failure. EPs diagnosed DD based on $e'_A < 9$ cm/s alone. A blinded board-certified cardiologist reviewed LBEs to estimate LA filling pressures following ASE guidelines. An unweighted kappa measure was calculated to determine agreement between EP and cardiologist.

Results: Six LBEs were deemed indeterminate by the cardiologist and excluded from the analysis. Agreement was reached in 41 out of 48 cases (85.4%). The unweighted kappa coefficient was 0.74 (95% CI 0.57–0.92). EPs identified 18 out of 20 LBEs diagnosed with diastolic dysfunction by the cardiologist.

Conclusion: There is a good agreement between (e'_A) by EP and cardiologist interpretation of LBEs. Future studies should investigate this simplified approach as a one-step method of screening for LV diastolic dysfunction in the ED.

Introduction

Diastolic dysfunction (DD) is an alteration of relaxation, filling, and/or distensibility of the left ventricle [1]. DD can lead to diastolic heart failure and increases the risk of readmission rates and in-hospital mortality [2]. The increased prevalence of DD has led to growing interest in early detection in acute care settings [3, 4].

The American Society of Echocardiography (ASE) guidelines outline a detailed algorithm for the diagnosis of DD which includes (1) spectral pulsed wave Doppler of transmitral inflow; (2) pulsed wave Doppler profile of pulmonary venous flow; (3) mitral annulus downward velocity measurements (e') using tissue Doppler imaging (TDI) at the septum (e'_S) and lateral wall (e'_L); and (4) left atrial (LA) volumes [5]. Obtaining these multiple measurements may be time-consuming and difficult for the average EP.

Average peak mitral annulus velocity by TDI ($e'_A = [e'_S + e'_L]/2$) has been described as an acceptable single-step method for assessing LV relaxation, using $e'_A < 9$ cm/s as a threshold [6–9]. TDI measurements can be obtained in 30 s with nearly 100% success rate, even with poor echocardiographic windows [10, 11]. This simplified approach may be more suitable for use by EPs with limited experience in echocardiography.

The purpose of this study was to ascertain inter-rater agreement in DD determination between $e'_A < 9$ cm/s measured by EPs and cardiologist interpretation of LBEs following the ASE guidelines.

Methods

Study design

This was a secondary data set analysis of LBEs completed as part of a prospective, cross-sectional with longitudinal

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follow-up study (details provided elsewhere) of patients presenting to the emergency department (ED) with asymptomatic elevated blood pressure [12, 13].

Study protocol and measurements

LBEs were performed based on research staff availability by EPs (two emergency ultrasound fellowship-trained faculties and one emergency ultrasound fellow) who had performed at least 100 LBEs through routine clinical care and who underwent training and demonstrated proficiency in diastology with a board-certified cardiologist. A sonosite M-Turbo ultrasound system equipped with a harmonic 4.0-MHz variable-frequency phased-array transducer was used to obtain images and measurements. Studies were digitally archived for cardiologist review.

EPs utilized electrocardiogram (EKG) rhythm strips to time diastole. EPs determined e'_A by averaging e'_S and e'_L measurements. EPs considered an $e'_A < 9$ cm/s as evidence of DD without adjustment for age or other risk factors. A board-certified cardiologist with an ASE level III echocardiography certification independently reviewed LBE images while blinded to EP interpretation. The cardiologist rated the images in accordance to the 2009 ASE guidelines [8] and upon reviewing digital recordings of the following: parasternal long view for determination of LV wall thickness, apical four-chamber view for estimation of LA size, E and A measurements, e'_S and e'_L, E/e' ratios to assess LA pressure, estimation of LA size, and the EKG rhythm strip (see Table 1 for comparison of data interpretation).

Data analysis

EPs and cardiologist indicated DD present, DD absent, or indeterminate for each LBE study. A 3 × 3 contingency table provided a summary of agreement. Inter-rater reliability between EPs and the cardiologist was determined using an unweighted kappa with 95% confidence interval (CI) coefficient using Stata Release 15, StataCorp.

Results

Forty-eight studies were submitted to the cardiologist for review. Cardiologist and EP agreement are summarized in Table 2. Agreement was reached in 41 out of 48 cases (85.4%). The unweighted kappa coefficient was 0.74 (95% CI 0.57–0.92).

Discussion

Diastolic dysfunction is prevalent and delays in diagnosis can lead to increased morbidity and mortality. EPs with focused training in diastology may identify diastolic dysfunction with high sensitivity compared to a cardiologist trained in echocardiography. Previous studies have demonstrated that EPs can identify DD with high sensitivity, but either did not include TDI as part of their assessment [14] or reported only moderate agreement with cardiologist interpretation [4]. One study showed that EPs who met minimum requirements for LBEs based on American College of Emergency Physicians guidelines demonstrated high inter-rater agreement in the assessment of DD using primarily TDI, but failed to compare EP to a cardiologist interpretation [15]. Our study addresses the limitations of previous evidence by demonstrating that by

Table 2 Agreement between emergency physicians and cardiologist interpretation

Emergency physicians	Cardiologist		
	DD present	DD not present	Indeterminate[a]
DD present	18	0	1
DD not present	2	22	4
Indeterminate[b]	0	0	1

[a] Studies were rated "indeterminate" by cardiology based on the following: fused E and A waves (1), studies that met some criteria but not others (4), and clips with insufficient number of cycles recorded (1)

[b] One study was rated "indeterminate" by emergency physicians due to extremely disparate e' septal and lateral measurements

Table 1 Comparison of data utilized by emergency physician vs. cardiologist for determination of diastolic dysfunction

Interpretation by	Data collected	Interpretation
Emergency physician	TDI measurements mitral annulus (i.e., e'_S and e'_L)	Average TDI velocities at mitral annulus (i.e., e'_A)
	Sinus EKG rhythm strip	Timing of early and late diastole
Cardiologist	Clip of PSL view	LV wall thickness estimation
	Clip of apical 4-chamber view	LA diameter
	Mitral valve inflow velocities measurements (i.e., E and A)	E/A ratio
		E/e' to estimate LA pressure
	TDI measurements mitral annulus (i.e., e'_S and e'_L)	E/e' to estimate LA pressure
	Sinus EKG rhythm strip	Timing of early and late diastole

TDI, tissue Doppler imaging; PSL, parasternal long, e'_S, mitral annulus downward velocity at the septum; e'_L, mitral annulus downward velocity at the lateral wall; e'_A, average mitral annulus downward velocity measured ($[e'_S + e'_L]/2$); E, peak mitral valve inflow velocity in early diastole; A, peak mitral valve inflow velocity in late diastole; LA, left atrium; LV, left ventricle following a more simplified approach using e'_A alone, EPs can identify DD with high level of agreement compared to a cardiologist following the ASE guidelines.

Limitations

Our sample size and convenience sampling may have introduced selection bias thus preventing a definitive correlation between e'_A and DD. EPs did not screen for regional wall motion abnormalities. Because wall motion abnormalities of the left ventricular basal segments can influence mitral annulus TDI diastolic velocities, this may have led to an overestimation of DD prevalence. Moreover, comparison was limited to cardiologist interpretation of LBE images, which may not be representative of typical exams obtained by a technician or specialist. A larger, multi-center study comparing EP assessment of e'_A against performance of a comprehensive echocardiogram can help establish external validity.

Conclusions

This study highlights a promising simplified approach for identifying DD by EPs. Relying on e'_A alone achieved good agreement for determination of DD compared to LBE interpretation by cardiologist. Future studies should further investigate this simplified approach as a one-step method of screening for LV DD in the emergency department.

Authors' contributions
All authors have contributed to both the collection of data and the writing of the article. All authors read and approved the final manuscript. The authors would like to acknowledge the Research Open Access Publishing (ROAAP) Fund of the University of Illinois at Chicago for financial support towards the open access publishing fee for this article.

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Competing interests
The authors declare that they have no competing interests.

Availability of data and materials
This manuscript adhered to institutional policies regarding ultrasonography image collection and research. For access to full dataset, please contact corresponding author by e-mail.

Consent for publication
All patients gave written consent to participation in the study and the publication of the results.

Ethics approval and consent to participate
The University of Illinois at Chicago Institutional Review Board approved the study protocol.

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