



# Systolic Myocardial Velocity by Tissue Doppler Imaging versus Left Ventricular Ejection Fraction by Simpson's Method in Yemeni Patients with Heart Failure

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## ABSTRACT

**Objective:** To compare between systolic myocardial velocity (Sm) by tissue Doppler imaging (TDI) and left ventricular ejection fraction (LVEF) by Simpson's method in Yemeni patients with heart failure (HF).

**Method:** This study included 85 HF patients whose LVEF was <50.0%. LVEF was measured by Simpson's method and Sm was measured by TDI at septal, lateral, anterior and inferior sides of the mitral annulus.

**Results:** The mean age of the patients included in the study was  $58.5 \pm 11$  years. The mean LVEF was  $33.53 \pm 9.94$ , while LV mean Sm (cm/s) was  $2.67 \pm 1.43$ . A significant correlation was detected between LVEF obtained by Simpson's method and LV mean Sm obtained by TDI ( $r = 0.609$ ,  $P < 0.001$ ).

**Conclusions:** A significant correlation was found between LVEF and Sm among Yemeni patients with HF. Therefore, Sm obtained by TDI can replace LVEF in the assessment of LV systolic function in Yemeni HF patients. Large-scale, controlled studies are recommended to provide further evidence on the utility of Sm by TDI in assessing the LV systolic function in HF patients in different areas of the country.

**Keywords:** Systolic myocardial velocity, Tissue Doppler imaging, Left ventricular ejection fraction, Simpson's method, Heart failure, Yemen

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## 1. Introduction

Heart failure (HF) is a syndrome of high morbidity and mortality rates that increases with aging of the population.<sup>(1)</sup> Because of the lack of other parameters for measuring the systolic heart function, left ventricular ejection fraction (LVEF) is widely used as a parameter to evaluate cardiac function in clinical practice.<sup>(2)</sup> with regard to prognosis, LVEF measurement can help in certain conditions because it depends on preload, postload, heart rate, contractility and dyssynchrony.<sup>(2)</sup>

Myocardial fibers are not uniformly distributed across the left ventricular (LV) walls.<sup>(3)</sup> Sub-endocardial and sub-epicardial muscle bundles are aligned longitudinally, while the fibers in the middle of the wall are arranged circumferentially and mainly responsible for LV radial axis contraction.<sup>(3)</sup> The longitudinal fibers of cardiac muscles are responsible for longitudinal contraction and pump function of the heart.<sup>(4, 5)</sup> Because the longitudinally arranged fibers at the heart base are attached to the atrioventricular ring, the changes in the longitudinal axis can be measured by the movement of the atrioventricular ring.<sup>(3)</sup>

Based on the above, measuring longitudinal systolic myocardial function is beneficial and can be measured by tissue Doppler imaging (TDI). TDI is a technique in echocardiography to analyze systolic and diastolic myocardial velocities obtained from mitral annuli for evaluation of the global and regional LV longitudinal functions that are not affected by the image quality or the geometric shapes of the left ventricle.<sup>(6, 7)</sup> Recently, systolic myocardial velocity (Sm) obtained by TDI has been assumed to be an alternative method for assessing systolic function of the heart, <sup>(8–15)</sup> by which a cutoff value of systolic velocity (S') greater than 7.5 cm/s had a sensitivity of 79% and a specificity of 88% in forecasting the normal global LV function.<sup>(13)</sup>

This study aimed to assess the average Sm as an alternative parameter to LVEF for patients with poor image quality because it is not dependent on

preload, postload, heart rate, contractility and image quality.

## 2. Methods

### 2.1. Study subjects

This study included 85 HF patients presented to Al-Gamhouria Teaching Hospital and private clinics in Aden city - Yemen between January 2016 and July 2017 with signs and symptoms matching the European Society of Cardiology Clinical Practice Guidelines for Heart Failure. Exclusion criteria included LVEF  $\geq$  50%, severe renal failure, congenital heart disease, cor pulmonale, atrial fibrillation pacemaker, inadequate visualization and valvular diseases.

### 2.2. Echocardiographic evaluation

Echocardiographic examinations were performed by an experienced cardiologist using a standard protocol by E-CUPE9 echocardiography machine with a 3.5 MHz transducer (ALPINION Medical Systems, Gyeonggi-do, Korea). Echocardiographic parameters were measured according to the American Society of Echocardiography, and the values of each parameter were the average of three successive cardiac cycles. LVEF was measured by 2D echocardiography obtained by modified Simpson's method from the apical four-chamber view. Pulsed-wave TDI was performed by activating the TDI function in the same echocardiographic machine. In the apical four-chamber view, a 3.5-mm sample volume TDI cursor was put at the septal and lateral sides of the mitral annulus. Similarly, in the apical two-chamber view, the TDI cursor was put at the anterior and inferior sides of the mitral annulus. Sm parameter was measured at each segment, and LV mean value of Sm was considered as the average of the four sites.



### 2.3. Statistical analysis

Data were analyzed using IBM SPSS Statistics, version 20 for Windows® (IBM Corp., Armonk, NY, USA). Quantitative data of parameters were presented as mean  $\pm$  standard deviation, while frequencies and proportions were used to present data of categorical variables. Pearson's coefficient was used to analyze the linear correlation between quantitative variables. *P*-values  $<0.05$  were considered statistically significant.

## 3. Results

The mean age of the patients included in the study was  $58.5 \pm 11$  years. Of the 85 patients, the majority were males (87.1%), hypertensive (65.9%), diabetic (43.6%), with history of coronary artery disease (82.4%) and dyslipidemic (71.8%). The mean LVEF was  $33.53 \pm 9.94$ , while LV mean Sm (cm/s) was  $2.67 \pm 1.43$  (Table 1). A significant correlation was detected between LVEF obtained by Simpson's method and LV mean Sm obtained by TDI ( $r = 0.609$ ,  $P < 0.001$ ).

**Table 1.** Characteristics of patients (N = 85)

Variable	n(%)
Mean Age (years) $\pm$ Standard deviation(SD)	58.48 $\pm$ 11
Gender	
Males	74 (87)
Females	11 (13)
Causes of heart failure	
Ischemic	70 (82.4)
Non-ischemic	15 (17.6)
Hypertension	56 (65.9)
Diabetes mellitus	37 (43.6)
Dyslipidemia	61 (71.8)
LV ejection fraction (Mean $\pm$ SD)	33.53 (9.94)
LV average Sm (cm/s)	2.67 (1.43)

## 4. Discussion

This study is the first to compare between Sm by TDI and LVEF by Simpson's method for the assessment of LV systolic function in HF patients in Yemen. It revealed that spectral TDI could be used when LVEF is hard to assess due to poor image quality, providing a simple quantitative approach to the prediction of LVEF. The correlation between these two parameters was found to be strong.

In clinical practice, LV systolic function is mostly assessed by ejection fraction according to the modified Simpson's method that depends on the quality of images and LV geometric shapes. However, this becomes unsuitable in patients with acute myocardial infarction because the visibility of the endocardium is nearly impossible due to poor image quality. In contrast, TDI is useful because it does not depend largely on image quality.<sup>(16)</sup> Moreover, LVEF calculation by Simpson's method is time-consuming and user-dependent.<sup>(17)</sup>

TDI can be used to assess the longitudinal contraction of the cardiac muscles and is more sensitive than traditional methods to assess regional and global LV functions by measuring of myocardial velocities.<sup>(6, 7, 18)</sup> Sm obtained by TDI has been suggested to be an alternative method in the assessing systolic functions in a number cardiac diseases.<sup>(8-15)</sup> A strong correlation was found between LVEF obtained by modified Simpson's method and Sm parameter derived by TDI in patients with HF.<sup>(19)</sup> In addition, it has been reported that Sm decreases in parallel to LVEF in HF patients.<sup>(20, 21)</sup>

The present study is limited by the fact that it did not include normal individuals or patients with preserved LVEF. In addition, it did not involve specific conditions with atrial fibrillation, conduction abnormalities, pacemakers and prosthetic valves.

## 5. Conclusions

A significant correlation was found between LVEF and Sm among Yemeni patients with HF. Therefore, Sm obtained by TDI can replace LVEF in the assessment of LV systolic function in Yemeni HF patients. Large-scale, controlled studies are recommended to provide further evidence on the utility of Sm by TDI in assessing the LV systolic function in HF patients in different areas of the country.



## Ethical considerations

This study approved by the Ethics Committee of the Faculty of Medicine and Health Sciences, Aden University, Aden, Yemen. Informed consent was obtained from patients after clear explanation of the study objectives.

## Acknowledgments

The author thanks patients for their participation in the present study.

## Competing interests

The author declares that she has no competing interests associated with this article.

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