Cardiology Research and Cardiovascular Medicine
Bakr T, et al. Cardiolog Res Cardiovasc Med 8: 214.
www.doi.org/10.29011/2575-7083.100214
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Research Article

Myocardial Performance Index by Pulsed Wave Doppler versus Tissue Doppler Echocardiography in Left Ventricular Systolic Function Assessment

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Citation: Bakr T, Sahal N, Nasim M, Mahmoud M, Elsharkawi A, et al. (2023). Myocardial Performance Index by Pulsed wave Doppler versus Tissue Doppler Echocardiography in Left Ventricular Systolic Function Assessment. CardiolResCardiovascMed8:214. https://doi.org/10.29011/2575-7083.100214

Received Date: 16 November, 2023; **Accepted Date:** 21 November, 2023; **Published Date:** 0 November, 2023

Abstract

Aims: to investigate the agreement between TDI-MPI and PWD-MPI in assessing left ventricular systolic function and to evaluate the correlation of the two methods with ejection fraction (EF). **Methods and results:** We retrospectively analyzed 60 subjects undergoing Echocardiographic assessment at the Echocardiographic Unit in our hospital between January 2023 and August 2023, excluded from the study Atrial Fibrillation, Bundle Branch Block and other conduction defects, Congenital Heart Disease, Valvular Heart Disease, Chronic Obstructive Lung Disease, data was collected and tabulated, including demographic data and the measurements, pulsed wave doppler and tissue doppler values of MPI were measured, the results were then analyzed. **Conclusion:** The TDI-MPI was associated with a stronger negative correlation than PWD-MPI to the left ventricular EF and a stronger positive correlation to the ejection time, while TDI-MPI is equal to the one assessed by PWD-MPI in healthy subjects so higher TDI-MPI values are expected than PWD-MPI values as EF gets lower.

Keywords: Echocardiography, Myocardial Performance Index, Pulsed wave Doppler, Tissue Doppler

Introduction

The myocardial performance index (MPI) or Tei Index, described more than a decade ago, has been well documented in the literature as a prognostic and progression marker for various heart diseases [1]. Accurate assessment of ventricular wall movements during the cardiac cycle depends on image quality. Patient characteristics, operator skills, and instrument settings influence optimal image acquisition. Proper patient positioning helps to optimize the imaging of parasternal and apical views. Images are best acquired at end-expiration or during quiet respiration. Failure to accurately visualize the endocardial border introduces uncertainty into 2D measurements. [2].

The Myocardial Performance Index (MPI/Tei Index), which includes both systolic and diastolic time intervals to assess global cardiac dysfunction was used by Tei and his co-workers in 1995 [3]. One limitation of the conventional Doppler-derived Myocardial Performance Index (PWD-MPI) method is that the measures of time intervals are based on flow-velocity curves and are performed in different cardiac cycles; this method requires several measurements to reduce beat-to-beat variation. An alternative for MPI calculation is the use of the pulsed-wave

tissue Doppler imaging-derived myocardial performance index (TDI-MPI), which allows simultaneous measurement of both the diastolic and systolic intervals in the same cardiac cycle, with high diagnostic accuracy in subjects with heart failure and left-ventricular dysfunction [4].

Because of this, results may be less reliable in the presence of heart rate fluctuation Tissue Doppler echocardiography (TDE) provides reliable data about the global and regional ventricular functions and makes it possible to calculate the systolic and diastolic time intervals in the same cycle used in MPI calculations. Because of these advantages, it is recommended as an alternative method to conventional ones, and currently, it is being used in the evaluation of ventricular function in cardiac diseases [5].

Methods

Study Population

The study included 60 subjects undergoing Echocardiographic assessment at Echocardiographic Unit in our hospital. Exclusion criteria were Atrial Fibrillation, Bundle Branch Block and other conduction defects, Congenital Heart Disease, Valvular Heart Disease, and Chronic Obstructive Lung Disease.

Echocardiographic evaluation was done using A Philips Sonos 7500 (Andover, MA) phased array system, Agile Kontron phased array system, and a Vivid phased array system equipped were used. Complete Transthoracic Echocardiographic examination, including Conventional Echocardiography and Tissue Doppler Echocardiography

All echocardiographic examinations were performed after 20–30 min of rest with the patient in quiet respiration in the partial left lateral decubitus position, using a 2–4 MHz transducer, and accompanied by recording resting electrocardiography.

All measurements were obtained online, and Echocardiographic parameters were measured according to the American Society of Echocardiography Values for each parameter obtained by averaging measurements from three successive cardiac cycles.

a. Left atrium dimension (LA): Measured in the long axis parasternal view on the same line with the aortic valve leaflets between both leading edges.

b. LV systolic function: by calculating Ejection Fraction (EF) using the Biplane method (Simpson's method), Done by manual tracing of the endocardial border of LV in the apical four chambers and apical two chambers' views for detecting LVEDV, LVESV in both views for calculating EF.

c. Pulsed wave Myocardial Performance Index (PW-MPI) (Tie Index) Mitral inflow and left ventricular outflow velocity-time intervals were used to measure Doppler time intervals: The interval 'A' from the cessation to the onset of mitral inflow was equal to the sum of Isovolumetric Contraction Time (IVCT), Ejection Time (ET), and Isovolumetric Relaxation Time (IVRT.) Left ventricular ET 'B' was the duration of the left ventricular. Ejection during systole. Thus, the sum of IVCT and IVRT was obtained by subtracting 'B' from 'A'. The MPI was calculated as (A - B)/B.

d. Tissue Doppler Imaging (TDI). The mitral annular velocities were recorded using the pulsed-wave DTI by activating the TDI function in the echocardiography machine. A variable frequency phased array transducer (2.0-4.0 MHz) was used. The filter settings were kept low (0 Hz), and gains were adjusted optimally for good-quality velocity. A 1.7 mm sample volume was used. From the apical 4- and 2-chamber views, the following was calculated:

e. Myocardial performance index by tissue Doppler imaging (MPI-TDI).

This was done by:

TDI velocity time intervals were measured from the sites at the mitral annulus at the septal, lateral, anterior, and inferior sites. A mean value for the above four sites was used to assess the following times a) TDI isovolumetric contraction time (ICT) was measured between cessation of A' wave and onset of S´ wave, b) TDI ejection time (ET) was obtained between onset and cessation of S´ wave. c) TDI isovolumetric relaxation time (IRT) was obtained between cessation of the S wave and onset of the E' wave. MPI-TDI was calculated as (ICT+IRT)/(ET).

Results

There was a negative correlation between EF and Conventional MPI, $r = -0.64$ (P value < 0.0001), considered highly significant. There was a negative correlation between EF and TDI-MPI, $r = -0.75$ (P value < 0.0001), considered highly significant. There was a positive correlation between conventional MPI and TDI-MPI, $r = 0.69$ (P value < 0.0001), considered highly significant. There was a positive correlation between EF and Conventional ET, $r = 0.44$ (P value < 0.0001), considered highly significant. There was a positive correlation between EF and TDI-ET, $r = 0.62$ (P value < 0.0001), considered highly significant (Figures 1-4).

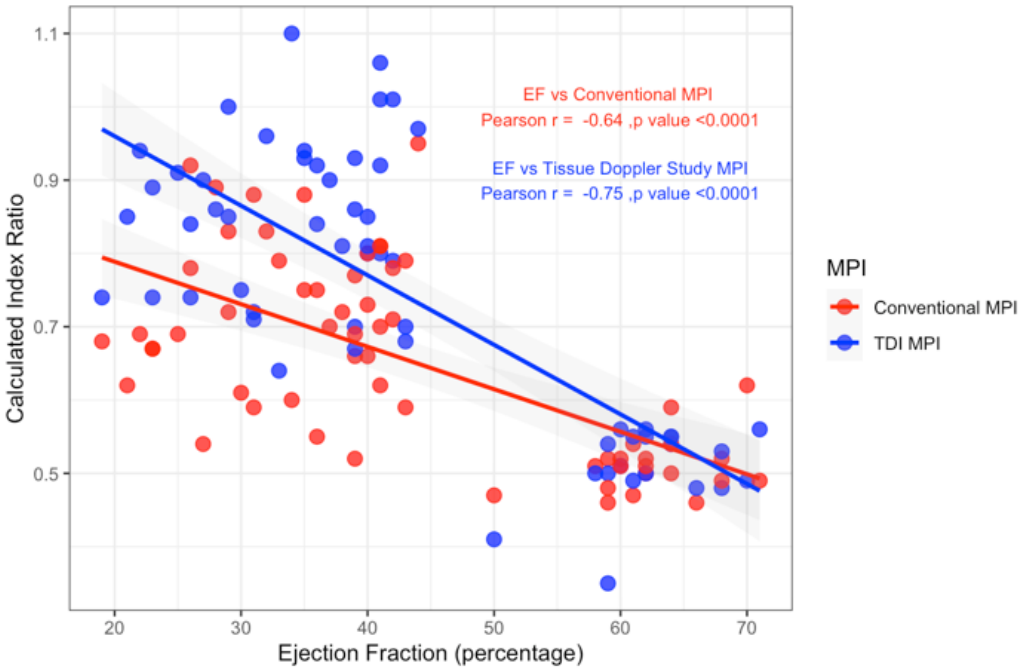

Figure 1: The relationship between EF, Conventional MPI & Tissue doppler MPI using all 60 cases in the study

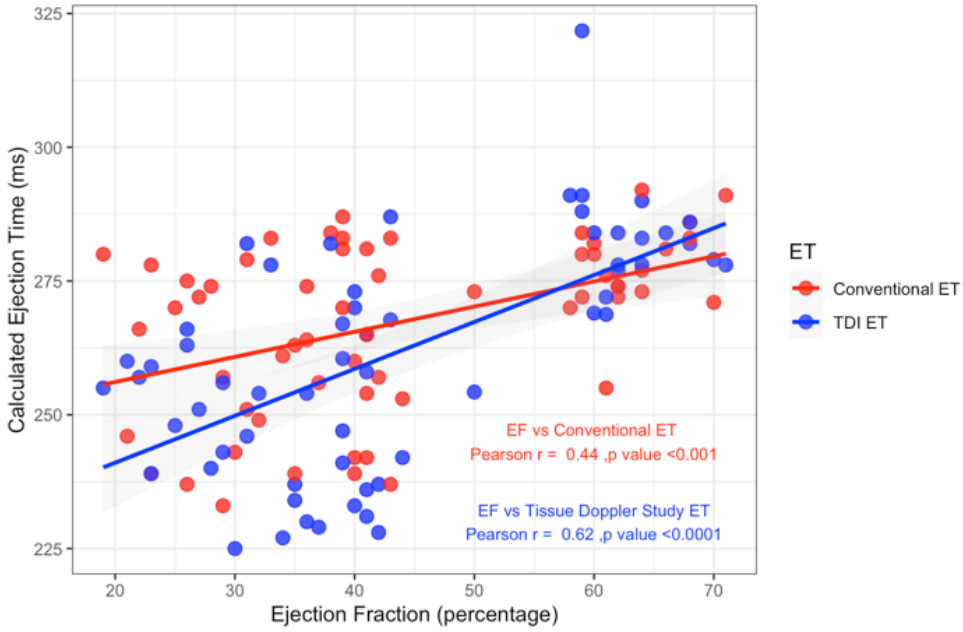

Figure 2: The relationship between EF, Conventional ET & Tissue doppler ET using all 60 cases in the study

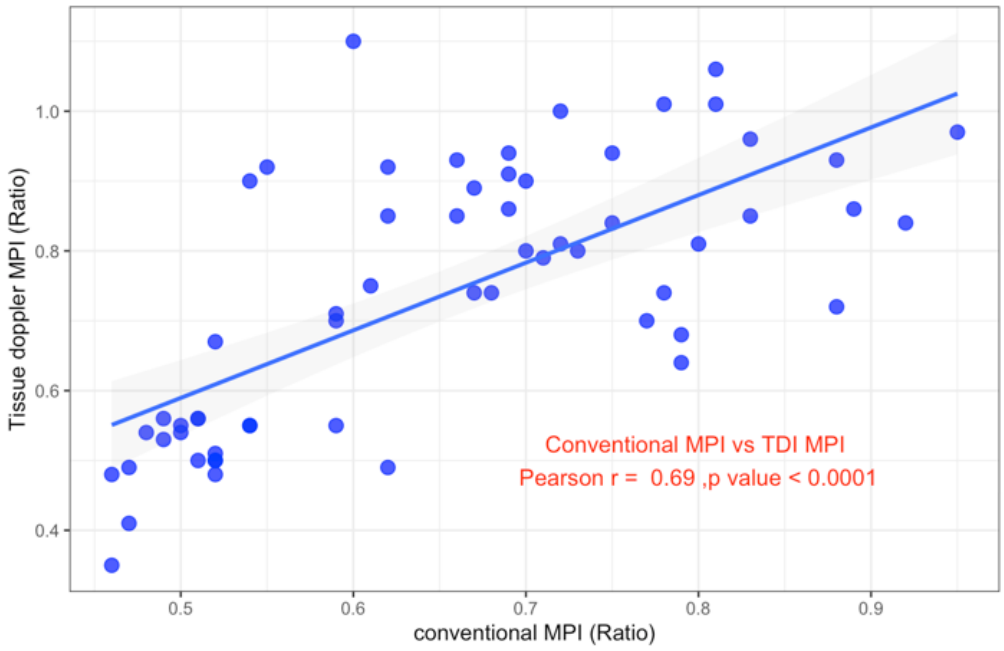

Figure 3: The relationship Conventional MPI & Tissue doppler MPI using all 60 cases in the study

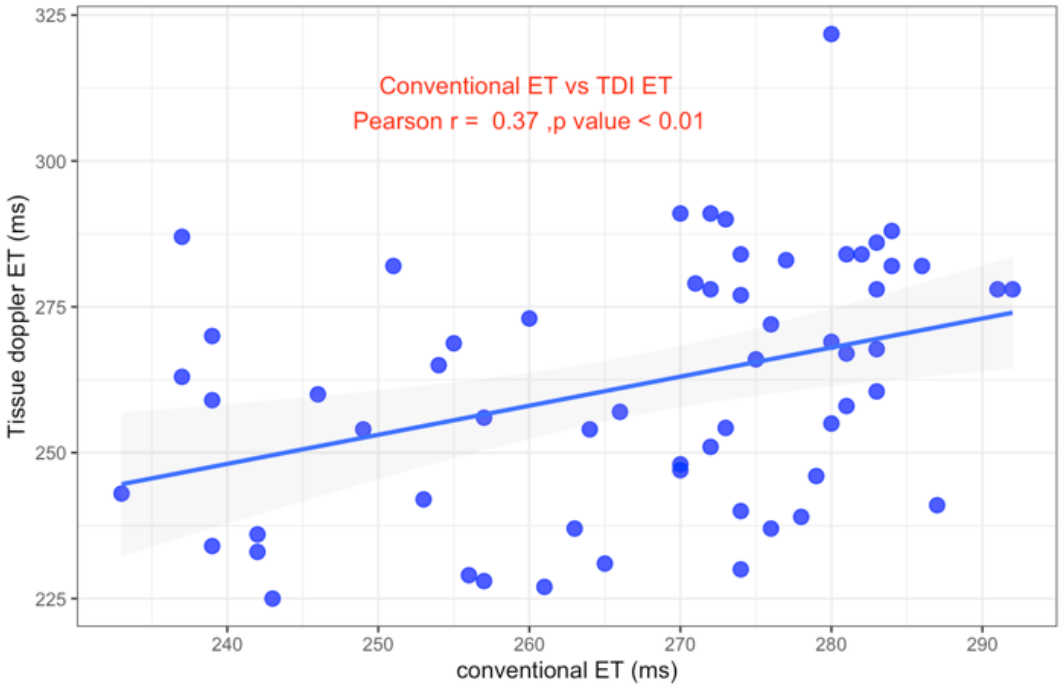

Figure 4: The relationship Conventional ET & Tissue doppler ET using all 60 cases in the study

Discussion

This study aimed to investigate the agreement between TDI-MPI and PWD-MPI in patients with left ventricular systolic dysfunction and to evaluate the correlation of the two methods with ejection fraction. For this purpose, we assessed left ventricular systolic function by Tei index obtained by the two methods (Conventional Doppler & Tissue Doppler Imaging) in sixty patients referred to our Echocardiography unit in our hospital between January 2023 and August 2023.

As regards the relationship between TDI-MPI and MPI by conventional method. TDI-MPI and PWD-MPI values were found to be similar in healthy subjects but different in patients with dilated cardiomyopathy, and a high agreement was reported to exist between the two methods.

TDI-MPI was measured from only the septal wall. Since the myocardial velocities obtained by TDI at the annulus are known to reflect the function of the adjacent regions, in the present study, we calculated LV TDI-MPI from the time intervals obtained from four different myocardial segments. However, we found that TDI-MPI was higher than PWD-MPI in patients with HF and the difference increases as the EF drops. In our study, there was a negative correlation between TDI-MPI and LVEF, as well as between conventional MPI and LVEF. Also, this study found a positive correlation between ET by both methods and EF. TDI-MPI and PWD-MPI were strongly positively correlated, TDI-ET and conventional ET were weakly positively correlated, suggesting MPI as a reliable method over ET.

Conclusion

The TDI-MPI had a stronger negative correlation than PWD-MPI to the left ventricular EF and a stronger positive correlation to the ejection time. At the same time, TDI-MPI is equal to the one assessed by PWD-MPI in healthy subjects, so higher TDI-MPI values are expected than PWD-MPI values as EF gets lower.

Funding: This research did not receive any specific grant from funding agencies.

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