CORRELATION OF ECHOCARDIOGRAPHIC DERIVED SYSTOLIC TIME INTERVALS IN HEART FAILURE PATIENTS WITH OTHER LEFT VENTRICULAR SYSTOLIC INDICES

Ahlam Kadhim Abbood¹, Zainab F. Hassan¹, Shokry F. Alsaad¹

1. College of medicine, University of Babylon, Iraq

*Corresponding Author E-mail: udayjanabia@yahoo.com (Abbood)

ABSTRACT

Despite the advanced echocardiographic techniques in assessment left ventricular systolic function, still there is a need for easy, reproducible and useful methods in difficult conditions. Aim of the study: evaluation the value of systolic time intervals in assessment left ventricular systolic function by comparison with conventional and advanced systolic indices. Total 57 patients with heart failure involved in the study, ECG and echocardiographic assessment had been done for them, measurement of systolic time intervals ( pre ejection period (PEP), left ventricular ejection time (LVET) ) and calculation the ratio: PEP / LVET were done. Correlation study were done between PEP and QRS width. Another correlation were done between these intervals and the measured stroke volume index (SI), cardiac index (CI) and global longitudinal strain (GLS). Correlation studies of PEP showed statistically significant positive correlation of QRS width (r = 0.54, p< 0.05), non-significant negative correlation of SI and CI (r = -0.06, -0.23, respectively, p> 0.05), and non-significant positive correlation of GLS (r = 0.12, p > 0.05). Correlation study of LVET showed statistically significant positive correlation with SI and CI (r = 0.91, 0.49, respectively), and statistically significant negative correlation with GLS (r = -0.32). P < 0.05. Correlation study of PEP/LVET showed statistically significant negative correlation with SI and CI (r = -0.54, -0.45 respectively), and statistically significant positive correlation with GLS (r = 0.36). p< 0.05. Correlation studies of PEP showed statistically significant positive correlation of QRS width (r = 0.54, p< 0.05), non-significant negative correlation of SI and CI (r = -0.06, -0.23, respectively, p> 0.05), and non-significant positive correlation of GLS (r = 0.12, p > 0.05). From these correlations it seems possible to get benefit from systolic time intervals in difficult conditions with poor windows and LV systolic assessment is important in therapeutic decision in heart failure patients.

Keywords: PEP, LVOT, heart failure

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INTRODUCTION

Systolic function of left ventricle in most circumstances is done by ejection fraction evaluation; this measure is with poor reproducibility. Other advanced measures like tissue Doppler image, 3D technique and speckle tracking have been involved in systolic function assessment (1-4) but these techniques are difficult, require good echo views and take long time (5).

So the need for simple with high reproducible measures for left ventricle systolic function seems to be mandatory especially in severely ill patients that need therapeutic decision as in heart failure patients. Previous studies demonstrated the role of systolic time intervals as easily applicable techniques at bedside with high repeatability (6,7). Electrical and mechanical events of the heart is essential part in assessment cardiac function as these events affected by diseased condition (8,9). Pre ejection period is one the measure that reflects these events and it resembles the time from the beginning of QRS complex to the onset of aortic flow. Evaluation of PEP is usually in association of others intervals that are called "systolic time intervals" for evaluation of conduction abnormalities (10). STI can be easily and accurately measured in clinical practice, and may be used for detecting alterations in LV systolic function. Moreover, this method is likely to have potential applications in the management of HF patients (5). These systolic intervals could be of value for assessing heart function in difficult conditions as some studies evaluated the role of them in cardiac resynchronization therapy in patients with heart failure (5, 11, 12). For that reason there was concentration on accurateness and repeatability of these intervals in comparison with other systolic parameters as LVET and GLS(5). This study aimed to evaluate STI in comparison with other indices like SI, CI and GLS, and to evaluate the relation between the PEP and QRS width that could be of value in heart failure patients who may need CRT.

MATERIAL AND METHODS

This cross sectional study included 57 patients with heart failure recruited from cardiac center, signed consent and approval from ethical committee at Babylon college of medicine had been taken from these patients. 2D- transthoracic echocardiography, pulsed Doppler were done by (VIVID 9 GE, with a 3.5-MHz transducer). 2D speckle tracking strain was evaluated in 44 patients, exclusion of the rest because of poor windows which affect strain results. The stroke volume (SV) was measured by continuity equation (13) this include measurement of left ventricular out flow tract (LVOT) diameter by parasternal long axis view, tracing the aortic flow obtained by pulsed Doppler on apical valve chamber view then according to continuity equation, SV can be calculated: \( SV = 0.785 \times D^2 \times VTI \) where D: diameter of LVOT, VTI: velocity time integral of LVOT flow. Cardiac output is measured from the equation: \( CO = SV \times HR \). Indexing SV and CO by dividing them on body surface area of the patients. PEP is assessed by measuring the time from the beginning of the QRS complex on the ECG to the beginning of aortic flow (by PW Doppler in apical 5-chamber view). LVET is the time from the beginning of aortic flow to the end of it. By dividing PEP/LVET can get index that reflects systolic function of left ventricle.
2D-SPECKLE TRACKING: Global longitudinal strain is measured by 2D speckle tracking. 2D speckle tracking is an offline procedure that is applied to acquired 2D images from apical three, four and two chamber views with frame rate 40-80 frames/s\(^{(14,16)}\). This technique is semi-automated, as full involvement of the wall thickness with exclusion of the pericardium should be assured. This may need manual adjustment besides the need for timing the end systole with the closure of aortic valve \(^{(17)}\). GLS was estimated in 44 patients only, the rest were with poor windows. ECG was done for every patient for measurement of QRS width.

RESULTS

Correlation studies of PEP showed statistically significant positive correlation of QRS width \(( r = 0.54, p < 0.05 )\), non-significant negative correlation of SI and CI \(( r = -0.06, -0.23, \) respectively, \( p > 0.05 )\), and non-significant positive correlation of GLS \(( r = 0.12, p > 0.05 )\). Figures 1, 2 (a, b, c), respectively (Table 1).

Table 1: Measures of the patients under study (mean ± SD)

<table>
<thead>
<tr>
<th>Measure</th>
<th>Value</th>
</tr>
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<tbody>
<tr>
<td>Age (years)</td>
<td>58±10</td>
</tr>
<tr>
<td>Body surface area -BSA(kg/cm(^2))</td>
<td>1.86±0.22</td>
</tr>
<tr>
<td>Heart rate - HR(beat/min)</td>
<td>88±22</td>
</tr>
<tr>
<td>QRS duration (ms)</td>
<td>120±33</td>
</tr>
<tr>
<td>Pre ejection period PEP-(ms)</td>
<td>133±29.4</td>
</tr>
<tr>
<td>Left ventricular ejection time -LVET-ms</td>
<td>196.9983±29</td>
</tr>
<tr>
<td>PEP/LVET</td>
<td>0.691±0.1</td>
</tr>
<tr>
<td>Stroke volume(ml)</td>
<td>43±13</td>
</tr>
<tr>
<td>Stroke volume index ml/beat.m2</td>
<td>23.3±7.5</td>
</tr>
<tr>
<td>Cardiac output l/min</td>
<td>3±1.38</td>
</tr>
<tr>
<td>CI L/min.m2</td>
<td>1.8±0.77</td>
</tr>
<tr>
<td>(GLS) %</td>
<td>-5.3±5</td>
</tr>
</tbody>
</table>
a. Correlation study of stroke volume index (SI) and pre ejection period (PEP).

b. Correlation study of stroke volume index (CI) and pre ejection period (PEP).
c. Correlation study of pre ejection period (PEP), global longitudinal strain (GLS)

Figure 2: Correlation studies of pre ejection period (PEP) and different cardiac systolic indices (a, b, c).

Correlation study of LVET showed statistically significant positive correlation with SI and CI (r = 0.91, 0.49, respectively), and statistically significant negative correlation with GLS (r = -0.32). P < 0.05. Figure 3 (a, b, c).

a. Correlation study of stroke volume index (SI) and left ventricular ejection time (LVET).
b. Correlation study of cardiac index (CI) and left ventricular ejection time (LVET).

c. Correlation study of global longitudinal strain (GLS %) and left ventricular ejection time (LVET).

Figure 3: Correlation studies of left ventricular ejection time (LVET) and different cardiac systolic indices (a,b,c).

Correlation study of PEP/LVET showed statistically significant negative correlation with SI and CI ($r = -0.54, -0.45$ respectively), and statistically significant positive correlation with GLS ($r = 0.36$). $p < 0.05$. Figure 4 (a, b, c).
a. Correlation study of stroke volume index (SI) and pre-ejection period/left ventricular ejection time (PEP/LVET).

\[ y = -21.367x + 38.107 \\
\text{r} = -0.54 \]

b. Correlation study of cardiac index (CI) and pre-ejection period/left ventricular ejection time (PEP/LVET).

\[ y = -1.8607x + 3.2929 \\
\text{r} = -0.45 \]
DISCUSSION

This study showed the prolonged PEP in these patients with heart failure and LV systolic dysfunction, and this in agreement of other studies \(^{(18)}\) which demonstrated that Left ventricular disease is commonly associated with prolongation of PEP. PEP showed positive correlation with widening of QRS as PEP reflects electromechanical events of the heart. Several studies showed that decreased systolic performance of the left ventricle associated with prolongation of PEP and shortening of LVET \(^{(12)}\) Previous studies showed that In case of LV failure, there is prolongation in the starting of ejection, with reduction of velocity of myocardial fiber shortening which cause short LVET, and in this study and other studiesLVET was found to be related to stroke volume \(^{(19-23)}\) this will affect LV output, so this could explain the results of thecorrelation studiesof PEP with SI, CI and GLSand thecorrelation of LVET with SI, CI and GLS. As PEP reflects electro-mechanical events and isovolumic contraction time. GLS is affected by both the isovolumic contraction period and themyocardial shortening, so prolongation of PEP is associated with reduce GLS that is demonstrated by the positive correlation between them.PEP is considered as index of contractility \(^{(24)}\). PEP and LVET are one of the important systolic indices as presented in this study and agree with other as Kasuki and his colleagues \(^{(11)}\). Prolongation of PEP and shortening of LVETHeart failure patients will reflect the high PEP/LVET value the worse systolic function.the PEP/LVETs were stated to be a valuable index of LV systolic function and this go with other studies like \(^{(12)}\). Despite the advanced methods in estimating systolic function, still the need for easily applicable and with high degree of
reproducibility, simplicity and accuracy, systolic time intervals showed to represent these properties\(^{(25)}\), and could be used for initial assessment and for follow up of the patients with poor windows especially in conditions need therapeutic decision as in cardiac defibrillator or CRT or optimization of stimulation\(^{(5,11,12)}\).

**CONCLUSION**

From these correlations it seems possible to get benefit from systolic time intervals in difficult conditions with poor windows and LV systolic assessment is important as in therapeutic decision in heart failure patients.

**ETHICAL CLEARANCE**

The Research Ethical Committee at scientific research by ethical approval of both environmental and health and higher education and scientific research ministries in Iraq

**CONFLICT OF INTEREST**

The authors declare that they have no conflict of interest.

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**REFERENCES**


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