Estimation of left ventricular end diastolic pressure (lvedp) in patients with ischemic heart disease by echocardiography and compare it with the results of cardiac catheterization

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Abstract

BACKGROUND: Doppler echocardiography has been proposed as an appropriate non-invasive assay to estimate left ventricular end diastolic pressure (LVEDP). The aim of present research was to estimate the LVEDP in patients with ischemic heart disease by echocardiography and compare it with the results of cardiac catheterisation and to determine the effect of different echocardiographic variables on its measurement.

METHODS: In this descriptive-analytic study, patients with diagnosed ischemic heart disease were selected by nonrandomized sampling method. Selected population underwent M-mode and pulse doppler echocardiographic evaluation and parameters such as Q-Mitral valve E (Q-MVE), Q-Aortic valve closure (Q-AVC), Aortic valve closure-E (AVC-E), Q-Mitral valve closure/Aortic valve closure-E (Q-MVC/AVC-E), left ventricle-deceleration time (LV-DT), peak velocity-deceleration time (PV-DT) and A/E velocity time integral (A/E VTI) were evaluated. Immediately after echocardiography all patients underwent left heart catheterization for LVEDP measurement. The relation between different echocardiographic measurements and LVEDP, obtained by cardiac catheterization, was evaluated.

RESULTS: In this study, 47 patients with ischemic heart disease with mean age (±SD) of 53 ± 13 were studied. There was a significant correlation between LVDEP and A/E VTI (r=0.44, P = 0.001, and also between LVEDP and PV-DT in patients with A/E VTI ≥1.1(r = -0.58, P = 0.02). There was a significant correlation between LVEDP and Q-MVC/AVC-E in patients with LVEDP >18mmHg (r = 0.76, P= 0.03) and those with LVEDP ≤18 mmHg and A/E VTI < 1.1 (r = 0.37, P= 0.03). The correlation between LVEDP and A/E VTI was more significant in men, in patients aged > 50 years with EF > 55%, without LVH, without MR and those with coronary artery disease (P < 0.05).

CONCLUSION: Some echocardiographic indices such as A/E VTI, Q-MVC/AVC-E and PV-DT are able to measure LVEDP especially in male patients aged > 50 years, without LVH, without MR and those with coronary artery disease but it is necessary to determine specific conditions and factors affecting these indices, by further studies.

Keywords: LVEDP, Coronary Artery Disease, Echocardiography.

Introduction

Coronary artery disease (CAD) is considered as the most common cause of morbidity and mortality worldwide, which results as the consequence of many complications such as ventricular dysfunction or hemodynamic problems.[1] Factors such as left ventricular end diastolic pressure (LVEDP), LV ejection fraction and systemic blood pressure have reported as the strongest predictors of morbidity and mortality related to ischemic heart diseases.[2]

In patients with ischemic heart disease evaluation

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of the LVEDP provides the assessment of hemodynamic severity and aids in the proper management and therapeutic interventions.[3] LVEDP is considered as an important factor in evaluating cardiac dysfunction during the follow up of patients who suffered myocardial infarction (MI) and is evaluated by using different techniques, including both invasive (cardiac catheterization) and noninvasive (echocardiography) approaches.[4,5] Though, there are studies that indicated the utility of noninvasive methods such as echocardiography in evaluating left ventricular diastolic dysfunction[6,7] but invasive techniques are predominantly used in this regard, the use of which is not without risks. It may be due to the fact that there is no informative research in this field in our region.

It seems that echocardiography which is a simple, noninvasive and safe technique for measurement of left ventricular diastolic dysfunction would be a valuable tool for evaluating the clinical status of patients.[8] In addition it could be properly used during the follow up period.

According to several researches Doppler echocardiography has been proposed as an appropriate non-invasive assay to estimate LVEDP ([9-13]). The aim of present research was to estimate the LVEDP in patients with ischemic heart disease by echocardiography and compare it with the results of cardiac catheterization and to determine the effect of different echocardiographic variables on its measurement.

Materials and Methods

In this observational (descriptive-analytic) study, patients with diagnosed ischemic heart disease referred to Chamran heart center for coronary angiography were included. Study population was selected by nonrandomized sampling method.

The study protocol was approved by the Ethics Committee of Isfahan University of Medical Sciences. Written informed consent was obtained from all participants.

Patients with non-sinus rhythm, chronic obstructive lung disease, primary pulmonary hypertension, moderate or severe mitral stenosis, and those with problems in measurement of LVEDP or poor echo-window were excluded.

Selected population underwent M-mode and pulse Doppler echocardiographic evaluation using Vingmed, CFM 750 device (Germany) with 3.25MHz transducer, in left lateral position. Two-dimensional

M-mode measurements were performed according to the recommendations of the American Society of Echocardiography[14] and some parameters were evaluated including: Q-Mitral valve E (Q-MVE), Q-Aortic valve closure (Q-AVC), Aortic valve closure-E (AVC-E), Q-Mitral valve closure/Aortic valve closure-E (Q-MVC/AVC-E), left ventricle-deceleration time (LV-DT), peak velocity-deceleration time (PV-DT) and A/E velocity time integral (A/E VTI).

Immidiatly, after echocardiography all patients underwent left heart catheterization (10-192 min after echocardiography) for LVEDP measurement.

A 7F fluid-filled catheter was placed in the LV using the right femoral percutaneous approach. The fluid-filled pressure was balanced and calibrated with the external pressure transducer positioned at the mid axillary level. All the recordings were performed before the injection of the contrast agent. The measurement of LVEDP was made at the nadir of the atrial contraction wave before the onset of rapid rise in LV systolic pressure. In cases without a clear atrial contraction wave, LVEDP was measured 50 msec after the onset of the QRS complex. The relation between different echocardiographic measurements and LVEDP obtained by cardiac catheterization was evaluated.

Statistical analysis

Data was analyzed using SPSS software. Obtained data from two procedures was presented as mean ± SD. Repeated measure ANOVA, multiple linear regression and correlation was used to determine the relation between LVDEP and echocardiographic measurements.

Results

In this study 47 patients with ischemic heart disease (30 men and 17 women) with mean age of 53 ± 13 (39-78 years old) were studied. Mean ± SD of echocardiographic and cardiac catheterization findings are presented in Table 1 and 2.

The relation between LVDEP and echocardiographic measurements using multiple linear regression and correlation indicated that there was a significant correlation between LVDEP and A/E VTI (r=0.44, Pvalue=0.001). Considering this correlation, the relation between LVDEP and echocardiographic measurements, according to different levels of LVEDP and A/E VTI, in studied patients was evaluated in six subgroups (Table3).

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Table 1. Findings of echocardiographic measurements (Mean ± SD or %)

Echocardiographic measurements	Mean ± SD or %
EF (%)	54% ± 8.6
LVH (%)	10 (21/3%)
Trivial MR (%)	5 (10.6%)
MR (%)	10 (21.3%)
LV-DT (msec)	0.15 ± 3.7
PV-DT (msec)	0.18 ± 0.12
Q-MVC/AVC-E	0.74 ± 0.66
A/E VTI (cm)	1.2 ± 1.08

Table 2. Findings of cardiac catheterization (Mean ± SD or %)

Findings of cardiac catheterization	Mean ± SD or %
LVEDP(mmHg)	17.4 ± 8.0
Results of coronary angiography	
-Normal or non significant	15 (31.9%)
-Single vessel disease	2 (4.2%)
-Two vessel disease	9 (19.1%)
-Three vessel disease	20 (42.6%)
-Left main artery stenosis	1 (2.1%)

Table3. The relation between LVDEP and echocardiographic measurements, according to different levels of LVEDP and A/E VTI

Subgroups	LVEDP & LV-DT	LVEDP & PV-DT	LVEDP & Q-MVC/AVC-E	LVEDP & A/E VTI	LVEDP & AVC-E
1.A/E VTI< 1.1	r = -0.02	r = 0.04	r = -0.21	r = 0.24	r = -0.08
n =33	P = 0.46	P = 0.40	P = 0.12	P =0.09	P = 0.34
2.A/E VTI >=1.1	r = 0.04	r = -0.58	r = 0.12	r =0.49*	r = -0.17
n =14	P = 0.45	P = 0.02*	P = 0.34	P = 0.04	P = 0.28
3.LVEDP >18mmHg	r = -0.34	r = -0.32	r = 0.60*	r = 0.76**	r =-0.36
n =11	P = 0.15	P = 0.17	P = 0.03	P =0.003	P = 0.14
4.LVEDP <= 18mmHg	r = 0.01	r = 0.07	r = -0.20	r = 0.33*	r = 0.08
n =36	P = 0.47	P = 0.34	P = 0.11	P = 0.02	P = 0.31
5.LVEDP <= 18mmHg & A/E VTI< 1.1	r =0.12	r = 0.03	r = -0.37*	r = 0.73**	r = 0.16
n =27	P = 027	P = 0.43	P = 0.03	P =0.00	P =0.21
6.LVEDP >18mmHg & A/E VTI >=1.1	r = -0.63	r =-0.46	r = 0.79	r =0.94**	r =0.50
n =5	P = 0.12	P = 0.22	P = 0.057	P =0.01	P =0.19

*P < 0.05
**P < 0.01

Considering the P value (<0.001) and the number of patients (n = 27) in the subgroup of LVED P <= 18 mmHg & A/E VTI< 1.1, three new formula for estimation of LVEDP by echocardiographic measureaments were performed using ANOVA test, as follows:

- LVEDP = 3.2+ 12.1 (A/E VTI)

- (Q-MVC/AVC-E) LVEDP = 3.8 + 11.6 (A/E VTI) - 0.4

- LVEDP = 3.8 + 11.6 (A/E VTI) - 0.4 (Q-MVC/AVC-E)

The correlation between calculated LVEDP by the three formulas, in 2-5 mmHg differences, is presented in Table 4.

Table 4. The correlation between calculated LVEDP by the three formulas in 2-5 mmHg differences

LVEDP <= 18mmHg	LVEDP= 3.2 + 12.1 (A/E VTI)	(Q-MVC/AVC-E)LVEDP = 3.8 + 11.6 (A/E VTI) - 0.4	LVEDP = 3.8 + 11.6 (A/E VTI) -0.4 (Q-MVC/AVC-E)
± 2mmHg difference	20(54%)	21(55.2%)	19(50%)
± 3mmHg difference	26(70.3%)	25(65.8%)	27(71%)
± 4mmHg difference	29(78.4%)	27(71%)	28(73.6%)
± 5mmHg difference	30(81.1%)	31(81.6%)	31(81.6%)

The correlation between LVEDP and A/E VTI was more significant in patients aged >50 years (r = 0.62, P<0.001), in men (r = 0.48, P=0.004), in patients with EF>55% (r = 0.71,P<0.001), in patients without LVH (r = 0.47, P<0.001), in patients without MR (r = 0.32, P = 0.038) and those with coronary artery disease (r =1, r = 0.70 and r =0.51 for 1VD, 2VD and 3VD, respectively and P < 0.001, P = 0.02 and P = 0.01 for 1VD, 2VD and 3VD, respectively)

Discussion

In this study estimation of LVEDP according to the echocardiographic measurements and in comparison with cardiac catheterization was evaluated. The results showed that there was a significant relation between LVEDP and some echocardiographic measurements such as A/E VTI, Q-MVC/AVC-E and PV-DT, from which the relation between A/E VTI and LVEDP were more significant. The correlation was more significant in patients aged>50 years, in men, in patients without LVH, in patients without MR and those with coronary artery disease.

Several studies, previously have reported the relation between different echocardiographic measurements and LVEDP and PCWP,[15-21] the indirect measurement of LVEDP.[22] But there were some differences between the current study and previous ones. In this study M-mode and pulse Doppler echocardiographic evaluation was done stimulantly and A/E VTI was measured by computer aided surface integral, during echocardiography. In addition related studies were in different groups of cardiac patients and the research tools were not similar also.[23,24] Thus, comparison of results with previous studies would be difficult because there was not a similar study.

Considering the significant correlation between LVEDP and A/E VTI, the correlation between different echocardiographic measurements and LVEDP was studied in six subgroups as presented in results section. Though there was significant correlation between LVEDP and A/E VTI in all studied subgroups, but the most significant correlation was observed in third, fourth and sixth subgroups. It seems that other factors had less effect on this correlation and A/E VTI considered as the most reliable echocardiographic index for LVEDP measurement.

Regarding Q-MVC/AVC-E index, the most significant correlation was observed in third subgroup. In the sixth subgroup, the correlation was significant but due to small sample size (n = 5), the P value was not significant, whereas in fifth subgroup the correlation was significant with low correlation rate. Considering the significant correlation between Q-MVC/AVC-E and LVEDP in patients with 2 vessel coronary artery disease with LVEDP>18 and A/E VTI<1.1, it seems that this index is useful for LVEDP measurement in patients with left ventricular dysfunction. In the study of Askenazi et al. a significant correlation was reported between PCWP and Q-MVC/AVC-E.[18]

There was a significant positive correlation between LVEDP and LV/DT in patients with 2 vessel coronary artery disease. Considering that LV/DT is the index related to ventricular stiffness which decrease during acute MI and increase in left ventricular dysfunction,[25] it seems that this index is useful for LVEDP measurement in patients with left ventricular dysfunction. In a study by Giannuzzi and colleagues among patients with left ventricular dysfunction, there was a significant correlation between PCWP and LV/DT.[21] Pozzoli et al, have reported a significant negative correlation between PCWP and LV/DT in patients with dilated cardiomyopathy.[21]Yamamuro et al have reported similar correlation ,in patients with acute MI.[15]

PV/DT commonly related to pulmonary vein flow pressure and compliance of left atrium and have less correlation with the compliance of left ventricle. In the current study there was a significant correlation between LVEDP and PV/DT in second subgroup. Though the correlation was significant in patients with trivial MR, but due to small sample size (n = 5), the P value was not significant. Considering the findings in this field, it seems that PV/DT could be an appropriate index for LVEDP measurement if

pulmonary vein flow pressure and it related effective factors determined accurately.

There was no correlation between LVEDP and ACV-E in this study. However ACV-E is the sum of IVRT and AT, which was not evaluated in any previous study in this field. Some studies indicated a correlation between IVRT and PCWP.[15]

The limitation of this study was that cardiac catheterization and echocardiography were not performed simultaneously. So, it is recommended that further studies plan in a way that ecocardiography perform in accordance with PCWP measurement using swan-ganz catheter.

In sum, some echocardiographic indexes such as A/E VTI, Q-MVC/AVC-E and PV-DT are able to measure LVEDP specially in patients aged>50 years, in men, in patients with EF > 50%, in patients without LVH, in patients without MR and those with coronary artery disease but it is necessary to determine specific conditions and factors affecting these indexes by further studies.

Conflict of Interests

Authors have no conflict of interests.

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