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Effect of Left Atrium Volume on Patients' Prognosis Following Acute Myocardial Infarction

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Abstract: Evaluating left atrium volume is a good way to estimate prognosis in acute myocardial infarction patients because it indicates to time and severity of diastolic dysfunction and longer-term results of acute myocardial infarction. The present study aims at evaluating the effect of left atrium volume on patients' prognosis following acute myocardial infarction. This is a cohort study conducted on 100 patients who were admitted with acute myocardial infarction. They were studied for 9 months and their one-month mortality rate was evaluated. The patients were studied considering demographic factors, risk factors, mechanical and arrhythmic complications and echocardiography indexes such as systolic and diastolic functions and left atrium volume. It was seen that mortality (27.3%, 6.22) in patients with atrium index>32 mL m^{-2} is more than cases with lower atrium index (1.3%, 1.78) ($p = 0.001$). There was not any meaningful difference in mortality rate of the patients considering age and gender ($p>0.05$). This study indicated to lack of any meaningful difference in patients' mortality rate in terms of hypertension, diabetes, smoking and dyslipidemia. But, mortality rate was significantly higher in MI as a result of elevated-ST, diastolic dysfunction, restrictive pattern, ejection fraction of left atrium<40%, left atrium volume index>32 mL m^{-2}. High volume left atrium independently refers to bad prognosis in patients with acute myocardial infarction which is confirmed with outcome clinical predictors and common echocardiography indexes even following modification.

Key words: Myocardial infarction, left atrium, echocardiography

INTRODUCTION

Diastolic function evaluated following acute myocardial infarction using Doppler echocardiography provides important prognostic information serving as supplementary information of those related to systolic function (Cameli *et al*., 2012; Costa *et al*., 2012; Lonborg *et al*., 2013). However, Doppler variables are affected by several factors and may quickly change due to after-load and preload variations (Goldust and Rezaee, 2013; Goldust *et al*., 2013a; Lotti *et al*., 2013). They reflect pulse interference to filling pressure pulse of left atrium and its compliance (Cho *et al*., 2012; Lamblin *et al*., 2012; Mohebbipour *et al*., 2012). Considering that preload and compliance have contradictory effects on speeds passing through normal mitral valve, mitral inflow may be pseudo normal although filling pressures of left atrium are abnormal (Goldust *et al*., 2013b; Sugimura *et al*., 2012; Wang *et al*., 2012) In spite of these limitations, it has been suggested that Doppler indexes of diastolic function predict morbidity and mortality in patients with acute myocardial infarction (Goldust *et al*., 2013c, d; Kuhl *et al*., 2011). A filling pattern of restrictive diastolic identified with a decreased EDT (E-Deceleration Time) indicates to high mortality (Sadighi *et al*., 2011; Vafaee *et al*., 2012; Zhang *et al*., 2011). During atrium diastole, left atrium is directly exposed to left atrium pressures through mitral valve (Goldust *et al*., 2012; Golfurushan *et al*., 2011; Milan *et al*., 2011). Therefore, left atrium size is mainly affected by those factors affecting diastolic filling of the left atrium (Antoni *et al*., 2011; Goldust *et al*., 2011; Sadeghpour *et al*., 2011). Additionally, it is more stable factor indicating to duration and severity of diastolic dysfunction (Fardiazar *et al*., 2012; Nikanfar *et al*., 2012; Sadeghpour *et al*., 2012). For this reason, it is supposed that left atrium volume predicts long-term results following acute myocardial infarction and may be preferred to Doppler indexes of diastolic function (Ganjpour Sales *et al*., 2012; Sakaguchi *et al*., 2011; Vahedi *et al*., 2012). Left atrium volume is less affected by acute changes and indicates to chronic or sub-acute diastolic function (Karzar *et al*., 2012; Seyyednejad *et al*., 2012; Shakeri *et al*., 2013). It becomes more important when evaluates the related risks in patients suffering from acute myocardial infarction (Farhoudi *et al*., 2012; Hsiao *et al*., 2011; Nourizadeh *et al*., 2013; Rodriguez-

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Granillo *et al*., 2012). The present study aims at approving effect of left atrium size on patients' prognosis following acute myocardial infarction.

MATERIALS AND METHODS

In this cohort study, 100 patients hospitalized with acute myocardial infarction panel at Shahid Madani hospital, Tabriz were evaluated form July 2011 to July 2012. The study was approved by ethic committee of Tabriz university of medical sciences. Written consent was obtained from all the patients. The patients underwent transthoracic echocardiography and left atrium volume, systolic and diastolic function, existence or nonexistence of MR were studied, demographic factors, atherosclerosis risk factors and MI complications were registered during the patients' hospitalization. The exclusion criteria were: Patients suffered from cardiac arrest following MI and underwent ventilation, patients suffered from a severe disease such as sepsis or acute renal failure and valvular diseases except to mitral insufficiency. Considering that LA volume is a accurate measurement of LA size in comparison with LA diameter at M-Mode, LA volume was indexed considering every patient's body area in this study. LA diameters were calculated at 4-cavity and 2-cavity views using following formula:

$$\text{LA volume} = D_1 \times D_2 \times D_3 \times 0.523$$

where, D_1 = Big diameter of left atrium at 4-cavity view, D_2 = Small diameter of left atrium at 4-cavity view and D_3 = Big diameter of left atrium at 2-cavity view. Another formula used in our study was as "Area":

$$\text{LA volume} = 0.85 \times A_1 \times \frac{A_2}{L}$$

where, A_1 = Area related to left atrium at 4-cavity view, A_2 = Area related to left atrium at 2-cavity view, L = D_1 = Big diameter of left atrium at 2-cavity view. The measured atrium volume was indexed with every patient's body area and left atrium volume index was obtained. LA volume index = LA volume/BSA. Then, the patients were divided into two groups with LA volume index = 32 mL m^{-2} and LA volume index<31.9 mL m^{-2}. Systolic function of left atrium was semi-quantitatively studied using visual method, wall motion index and Simpson technique. Systolic function (EF) = EDV-ESV/100EDV. Diastolic function was calculated in echo through studying mitral inflow at 4 chamber pulse wave Doppler view. E, A, wave, EDT and E/A ratio speeds were measured. Pulmonary veins flow was calculated with pulse wave and diastolic filling pattern was divided into three groups: normal, impaired relaxation and restrictive pattern. The patients were followed up through phone calls in order to study their survival. The study considered mortality for any reason. The obtained data was analyzed using SPSS-15 software. The quantitative and qualitative data was stated as standard deviation±mean and frequency percentage, respectively. Fisher's exact test or Chi-square test was used to compare the qualitative data considering conditions. Also, test was used to compare quantitative data. Logistic regression test was applied to multivariable analyze and (p = 0.05) was regarded meaningful in all cases.

RESULTS

The study evaluated 100 patients consisting of 82 men and 18 women. Mean age of the patients was 58.45 (33-88 years) years. In terms of left atrium volume, the patients were divided into two groups A (index = 32 mL m^{-2}) and B (index<32 mL m^{-2}). There were 22 and 78 cases in the groups A and B, respectively. Characteristics and findings of these two groups have been summarized and compared in Table 1. Accordingly, mean age of group A was higher than group B. Also, frequency of cases with hypertension, mitral insufficiency, restrictive pattern and mortality was meaningfully high in group B (p = 0.05). There was not any meaningful in other cases. Evaluating the variables in both survived and expired groups have been summarized and compared in Table 2. Frequency of cases with STEMI type MI, restrictive pattern and cases with left atrium index>32 was meaningfully higher in the expired group. Statistically meaningful difference was not observed in other cases. There was not any meaningful difference between patients' mortality rate considering atherosclerosis risk factors, according to one-variable analyses. But, mortality rate was significantly higher in STEMI type MI, diastolic dysfunction, restrictive pattern, ejection fraction of left atrium<40%, left atrium volume index>32 mL m^{-2}. Out of the above-mentioned factors, multivariable analysis (logistic regression) demonstrated that left atrium volume index>32 mL m^{-2} was an independent predictor of high one-month mortality rate of the patients [β (95%CI) = 21.66 (2.22-211.3), p = 0.008] (Table 3).

DISCUSSION

Left atrium volume index is a more sensitive risk marker for future cardiovascular events in comparison

Table 1: Patients characteristics and study findings in two groups with high and low index of left atrium volume

Variable	Low left atrium volume index (n = 78)	High left atrium volume index (n = 22)	OR (95% CI)	p-value
Age (year)	63±12	58±10	-	0.049
Gender (male)	64 (82.1)	18 (81.8)	1.02 (0.30-3.47)	1.000
Type of MI				
STEMI*	58 (74.4)	15 (68.2)	0.74 (0.26-2.07)	0.761
NSTEMI**	20 (25.6)	7 (31.8)	1.94 (0.526-7.19)	0.523
Location of MI				
Anterior	43 (55.1)	12 (54.5)	0.98 (0.38-2.53)	1.000
Others	31 (39.7)	10 (45.5)	1.05 (0.40-2.75)	1.000
Hypertension	24 (30.8)	12 (54.5)	2.70 (1.02-7.10)	0.040
Smoking	29 (37.2)	10 (45.5)	1.61 (0.34-3.11)	0.650
Diabetes mellitus	9 (11.5)	2 (9.1)	0.77 (0.15-3.83)	1.000
Revascularization	4 (5.1)	0 (0)	0.76 (0.69-1.86)	0.640
Hyperlipidemia	12 (15.4)	4 (18.2)	1.22 (0.35-4.20)	1.000
Severity of MI (killip = 2 or more)	2 (2.6)	3 (13.6)	6.00 (0.94-38.48)	0.069
Arrhythmia	4 (5.1)	3 (13.6)	2.92 (0.60-14.18)	0.364
History of MI	7 (9)	3 (13.6)	1.60 (0.38-6.79)	0.809
Mitral insufficiency (moderate to severe)	5 (6.4)	5 (22.7)	4.29 (1.12-16.52)	0.039
Diastolic dysfunction				
Impaired relaxation	61 (78.2)	14 (63.6)	0.49(0.18-1.36)	0.265
Restrictive pattern	9 (11.5)	7 (31.8)	3.58(1.15-11.13)	0.043
Receiving of streptokinase	49 (56.3)	13 (59.1)	0.86(0.33-2.25)	0.944
EF<40%***	21 (26.9)	10 (45.5)	1.77(0.67-4.64)	0.362
Mortality	1 (1.3)	6 (27.3)	28.87(3.25-256)	0.001

*: ST segment elevation myocardial infarction, **: Non-ST segment elevation myocardial infarction, ***: Ejection fraction

Table 2: One-variable analysis of factors predicting patients' mortality

Variable	Expired patients (n = 7)	Survived patients (n = 93)	OR (95%CI)	p-value
Older than 50 years	6 (85.7)	73 (76.5)	1.64 (0.19-14.46)	0.951
Male	6 (85.7)	76 (81.7)	1.93 (0.34-10.8)	0.807
Anterior myocardial infarction	3 (42.9)	52 (55.9)	0.59 (0.16-2.79)	0.783
STEMI*	2 (28.6)	71 (76.3)	0.25 (0.06-1.19)	0.063
Hypertension	2 (28.6)	34 (36.6)	0.28 (0.03-2.39)	0.405
Mellitus diabetes	1 (14.3)	10 (10.8)	0.92 (0.67-1.22)	0.735
Smoking	2 (28.6)	37 (39.8)	0.23 (0.09-2.11)	0.368
Dyslipidemia	1 (14.3)	15 (16.1)	0.87 (0.10-7.73)	1.000
Severity of MI (killip = 2 or more)	1 (14.3)	4 (4.3)	1.81 (0.21-8.07)	0.893
Arrhythmia	3 (42.9)	59 (63.4)	7.04 (1.09-45.73)	0.010
Mitral insufficiency (moderate to severe)	3 (42.9)	7 (7.5)	9.21 (1.71-49.62)	0.003
EF<40%**	2 (28.6)	30 (32.4)	5.25 (0.96-28.64)	0.036
Impaired relaxation	5 (71.4)	70 (75.3)	0.82 (0.15-4.52)	1.000
Restrictive pattern	1 (14.3)	15 (16.1)	0.93 (0.13-9.74)	0.865
Left atrium volume index = 32	6 (85.7)	16 (17.2)	28.88 (3.25-256)	0.001

*ST segment elevation myocardial infarction,**Ejection fraction

Table 3: Multivariable analysis (logistic regression) of factors predicting patients' mortality

Variable	B	Exp β (95% CI)	p-value
STEMI*	-1.72	0.18 (0.02-1.32)	0.092
Arrhythmia	1.68	5.36 (0.48-59.92)	0.173
EF<40%**	1.47	4.36 (0.56-33.74)	0.158
Mitral insufficiency	1.34	1.91 (0.33-38.4)	0.216
Left atrium volume index = 32	3.08	21.66 (2.22-211.3)	0.008

with diameter of area in patients with sinus rhythm (Fardiazar *et al*., 2013; Ganjpour Sales *et al*., 2013; Salehi *et al*., 2012). It has been shown that left atrium dilatation indicates to risk of cardiovascular diseases in absence of mitral valve disease or AF history (Caudron *et al*., 2011; Salehi *et al*., 2013a; Soleimanpour *et al*., 2013) The present study demonstrated that left atrium volume index is a more sensitive risk marker for future cardiovascular events in comparison with other risk factors of atherosclerosis and parameters. On the other hand, the study stated that diastolic dysfunction demonstrated with increasing the E/A ratio and shortening of EDT, is strongly associated with elevated mortality rate. Although, left atrium diameter is easily obtained in M-Mode, its efficiency has been recently challenged since left atrium is an asymmetric cavity (Boyd *et al*., 2010; Daghigh *et al*., 2013; Nemati *et al*., 2013). LA size is accurately obtained through measuring volume to area or its internal diameter ratio (Qadim *et al*., 2013; Razi *et al*., 2013; Salehi *et al*., 2013b). Additionally, LA dilatation may not be found in all planes and measuring anterior-posterior diameter may be insensitive to determine LA size (Golforoushan *et al*., 2013; Kayrak *et al*., 2010; Yousefi *et al*., 2013). In our study, left atrium volume index remained as a mortality predictor following acute MI even after its adjustment for systolic and diastolic function indexes. There are several possible explanations. LA volume indexes reflect duration and severity of LA pressure increase. In contrary, Doppler evaluation leads to an immediate evaluation of diastolic function. Therefore, a combination of parameters refers to acute and chronic diastolic dysfunction which have the best prognostic power (Azimi *et al*., 2013; Nejad *et al*., 2013; Chua *et al*., 2010). Previously conducted studies demonstrated that left atrium EF will not be an independent prognosis predictor when diastolic function evaluation is available (Antoni *et al*., 2010). In this study, Out of 35 patients with EF<40%, 10 cases had index>32 and 25 cases index<31.9. Also, out of 65 patients with EF>40%, high and low indexes were seen in 12 and 53 patients, respectively. In this study, it was found that if atrium volume index is normal in EF<40%, the outcomes will be good. It manifests that better hemodynamic before infarction may enable patients to maintain their myocardial contractility following a myocardial infarction (Rademakers *et al*., 2010). The study conducted about hypertension as one of the risk factors of atherosclerosis, it was proved that it is regarded as a powerful risk factor of mortality. Prevalence of hypertension was at higher levels in cases with high left atrium volume or high risk patients in terms of cardiovascular diseases (Leung and Ng, 2010). It seems that risk of left atrium high index and then mortality increases in other risk factors such as DM, smoking and dyslipidemia. EF was not an independent pre-detector about systolic dysfunction. There was a meaningful relationship between restrictive pattern and mortality rate considering systolic dysfunction. Higher atrium volume index and, therefore, increase of mortality are seen in patients with this pattern of diastolic dysfunction. This study confirmed high mortality rate in patients with higher killip class or moderate or severe mitral insufficiency following acute MI. Also, the present study indicated that type of MI (considering its location, STEMI or NSTEMI nature) was not an independent mortality predictor. In a study by Moller *et al*. (2003), left atrium volume was studied in patients with acute myocardial infarction using echocardiography. In their study, 314 patients with AMI underwent echocardiography and their systolic and diastolic function as well as left atrium volume was evaluated. During 15-month follow-up period, 15% of the patients died (Moller *et al*., 2003). In this study, left atrium volume was also an independent mortality predictor remained as a mortality predictor even after its adjustment with clinical factors, systolic and diastolic function and Doppler parameters of diastolic function. In (Tsutsui *et al*., 2008) study, importance of left atrium volume has been studied in DCM patients and it was observed that DCM patients have higher left atrium volume index. Also, in another study conducted by Meris *et al*. (2009). LAVI was evaluated in HCM patients. There were undesirable results including SCD and heart graft in higher LAVI diseases for HCM patients. Multivariable analyses of the study demonstrated that other clinical predictors such as LVEF, LVESVI and MR lost their independent importance in comparison with LAVI. In patients with first MI, killip class at the time of hospitalization was not an important independent predictor of 5-year mortality. LAVI maintained its importance in first ever acute MI. In this study, patients with atrium index>32 were older. They experienced high prevalence of hypertension, diabetes and history of revascularization. Most of them were NSTEM and rarely underwent PCI.

CONCLUSION

Comparing findings of our study with that of the similar ones, it was made clear that left atrium size is an important and independent mortality predictor following acute myocardial infarction. It is an easy and safe way to estimate risks in AMI patients in future.

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