Research Article

Severity of coronary artery disease and echocardiographic parameters of ventricular diastolic function in patients with non-ST-elevation acute coronary syndrome

Tanmay Mukhopadhyay[1], Ashish Gupta[2], Uttam Biswas[3], Biswakes Majumdar[1]

[1]Department of Interventional Cardiologist, Burdwan Medical College and Hospital, Purba Burdwan, West Bengal, India, [2]Department of Interventional Cardiologist, Dana Shivam Heart and Superspeciality Hospital, Jaipur, Rajasthan, India, [3]Department of Medicine, Burdwan Medical College and Hospital, Purba Burdwan, West Bengal, India

Correspondence to: Uttam Biswas, E-mail: druttambiswas@gmail.com

Received: October 08, 2018; **Accepted:** October 26, 2018

ABSTRACT

Background: Ischemic heart disease results in systolic and diastolic dysfunction (DD), but diastolic function seems to be more susceptible to ischemia than systolic function. Hence, we investigate the relationship between the extent and severity of coronary lesions and left ventricular (LV) diastolic function in patients with coronary heart disease. **Objective:** The objective of this study was to determine the relationship between the severity of the coronary artery disease (CAD) and LV diastolic function in patient with non-ST-elevation acute coronary syndrome (NSTE-ACS). **Materials and Methods:** A total of 109 patients with NSTE-ACS (NSTI myocardial infarction and unstable angina) were included in the study. All angiographic variables pertinent to SYNTAX score (SS) calculation were computed using online SS calculator. All patients underwent echocardiographic examination. **Results:** Echocardiographic parameters E/e', left atrial volume index (LAVI), and mitral inflow velocity (E/A) were measured in all patients and were found that an overall significant difference ($P < 0.0001$) in the SS between normal, Grade 1, Grade 2, and Grade 3 DD was seen. The significance of other parameters for determining DD, E/e', and LAVI was calculated using Spearman's correlation which also showed significant positive correlation with SS. 45.8% and 27.5% variation in the SS is accounted for E/e' and LAVI alone, respectively. **Conclusion:** The study shows a positive correlation between severity of CAD assessed using SS and E/A, E/e', and LAVI which are various determinants of DD.

KEY WORDS: Diastolic Dysfunction; Coronary Artery Disease; SYNTAX Score

INTRODUCTION

The importance of ischemic heart disease (IHD) in contemporary society is attested to by the almost epidemic number of persons afflicted. Ischemia can result in systolic and diastolic dysfunction (DD). DD results in ineffective left atrial (LA) emptying and left ventricular (LV) filling, reduces the ability to augment cardiac output with exercise,[1] increases in pulmonary pressure, and results in various symptoms. The significance of systolic dysfunction on coronary artery disease (CAD) is well recognized, increasing the rate of major adverse cardiovascular events. As disease progresses, DD is an increasing concern. DD affects the mortality rate and hospitalization significantly, resulting in the development of heart failure, hospitalization, and death.[2] Diastolic relaxation and filling appear to be altered by ischemia, which leads to asynchronous myocardial relaxation and thus affects global diastolic function.[3] Diastolic function seems more susceptible to ischemia than systolic function and can take longer to recover.[4,5] Diastolic function or inability of LV to relax occurs in a variety of heart diseases and often

Access this article online	
Website: http://www.ijmsph.com	Quick Response code
DOI: 10.5455/ijmsph. 2019.1029027102018	

predates the decline in LV systolic performance. Hence, the importance of DD is even more in NSTE-ACS which many at time presents with normal EF but still subsequently found to have severe CAD on angiography.[6,7]

Two-dimensional echocardiography has long been used for the evaluation of patients with ACS because it can assess global and regional LV function at bedside. In addition to LV systolic dysfunction and regional wall motion abnormalities, DD serves as an independent marker for poor prognosis in ST-elevation myocardial infarction (STEMI).[8] However, DD in NSTE-ACS (unstable angina and STEMI) has continued to be a gray zone area for a matter of debate.

Although there are data which support DD as a marker of poor prognosis in patients of STEMI,[9] to date, there is a paucity of research involving the relationship between DD and non-STEMI. The present study was designed to investigate the relationship between the extent and severity of coronary lesions and LV diastolic function in patients with coronary heart disease.

MATERIALS AND METHODS

Study Design and Subjects

In this cross-sectional study, 109 clinically diagnosed patients of NSTE-ACS (defined using the European Society of Cardiology/American College of Cardiology guidelines) admitted in the cardiology wards and Intermediate Coronary Care Unit (Department of Cardiology, Burdwan Medical College and Hospital of Burdwan district in West Bengal, India) were included with prior ethical permission from the Institutional Ethics Committee, irrespective of age, sex, and religion, over 2 years. Patients with stable angina, STEMI, ischemic cardiomyopathy, or alternate diagnosis for the chest pain were excluded from the study. Detailed history, clinical examination, biochemical, hematological investigations, electrocardiography, transthoracic echocardiographic (ECHO), and coronary angiographic findings were recorded for all patients.

Echo Parameters for DD

PHILIPS HD-7 dedicated 2D-ECHO machine was used for diastolic assessment of all patients and was carried out by single operator.

Parameters measured to assess the DD were LA volume index (LAVI), mitral inflow (patients were grouped in four categories: Normal, Grade 1, Grade 2 and Grade 3 and more), and E/e' ratio.

SYNTAX Scoring (SS)

SS was used to assess the severity of CAD. Given the high number of parameters concurring to generate the SS including the need for calculating a separate score for each lesion based on its anatomical location and technical challenges, the score computation requires some minutes and the use of specific tools. One of these is available at www.syntaxscore.com. We have used this online tool to calculate SS for all our patients.

Statistical Methods

Descriptive statistical analysis has been carried out in the present study. Results on continuous measurements are presented on mean ± standard deviation, and the results on categorical measurements are presented in number (%). Significance is assessed at a level of 5%. Normality of data tested by Anderson–Darling test, Shapiro–Wilk, Kolmogorov–Smirnov test, and visually by quantile-quantile plot. Analysis of variance has been used to find the significance of study parameters between three groups of patients. Unpaired *t*-test has been used to find the significance of study parameters between two groups of patients. Multivariate regression model is used to find the significant predictors of SS, a prognostic marker for CAD. The statistical software, namely SAS 9.2 and SPSS 21.0, was used for the analysis of the data, and Microsoft Word and Excel have been used to generate graphs and tables.

RESULTS

Subjects were grouped under four categories on the basis of E/A values, a parameter to determine DD in NSTE-ACS patients. 7 (6.4%) subjects were in normal group, 51 (46.8%) subjects in Grade 1 group, 32 (29.4%) in Grade 2 group, and 19 (17.4%) subjects in Grade 3 and more group. An overall significant difference ($P < 0.0001$) in the SS between normal, Grade 1, Grade 2, and Grade 3 was seen [Table 1].

The significance of other parameters for determining DD, E/e' [Figure 1], and LAVI [Figure 2] was calculated using Spearman's correlation which also showed significant positive correlation with SS. 45.8% and 27.5% variation in the SS is accounted for E/e' and LAVI alone, respectively [Table 2].

DISCUSSION

IHD is a growing pandemic of the modern world associated with high mortality and developing countries are worst hit with this menace.[10]

This study was conducted to assess a correlation between DD and severity of CAD in NSTE-ACS. There are various parameters to assess the DD, but the parameters considered in this study, i.e., E/A, E/e', and LAVI are easily studied in transthoracic echocardiography. These three parameters gives us an overall picture of diastolic dysfunction as and LAVI helps in understanding the long term assessment of the

Table 1: Correlation of SS with diastolic dysfunction (mitral inflow velocities)

SS										
E/A	n	Mean	SD	SE	95% confidence interval for mean		Minimum	Maximum	F	*P* (ANOVA)
					Lower bound	Upper bound				
Normal	7	12.29	12.632	4.775	60	23.97	2	39	23.026	<0.0001
Grade 1	51	15.67	9.214	1.290	13.08	18.26	3	41		
Grade 2	32	25.16	8.762	1.549	22.00	28.32	5	41		
Grade 3 and more	19	34.58	9.276	2.128	30.11	39.05	12	48		
Total	109	21.53	11.840	1.134	19.28	23.78	2	48		

ANOVA: Analysis of variance, SS: SYNTAX score, SD: Standard deviation, SE: Standard error

Table 2: Correlation of SS with E/e' ratio and LAVI

SS	E/e'	LAVI
Spearman correlation (rho)	677**	524**
P (two-tailed)	<0.001	<0.001
n	109	109
R^2	0.458	0.275

**Correlation is significant at the 0.01 level (two-tailed). LAVI: Left atrial volume index, SS: SYNTAX score

DD,[11,12] thereby enabling us a simultaneous assessment of acute and chronic situation.

Assessment of the severity of CAD was done using SS as it is one of the most validated scoring systems to assess the severity of CAD. It utilizes most of the anatomic variables of coronary artery lesions that define its complexity. Furthermore, with SS, interobserver variability is less.[13]

In our study, E/e′ and Left ventricular ejection index (LVEI), the other parameters for the assessment of DD also showed a positive linear correlation with SS (E/e′ [rho = 0.68, $P < 0.001$] and LVEI [rho = 0.52, $P < 0.001$]). 45.8% and 27.5% variation in the SS are accounted for E/e′ and LVEI alone, respectively. These findings correlate with the findings of Ohara and Little.[3] They also showed that the evaluation of DD has diagnostic and prognostic roles in the management of CAD. Du *et al*.[14] suggested that LV elevated end-diastolic pressure (LVEDP) was significantly associated with CAD as well as its extent and severity.

In our study, subjects were grouped under four categories on the basis of E/A values, a parameter to determine DD in NSTE-ACS patients. An overall significant difference ($P < 0.0001$) in the SS between normal, Grade 1, Grade 2, and Grade 3 was seen. Statistical significance between the groups was also calculated, and significant difference between all of the grades, but no significant difference in SS between normal and Grade 1 was seen. The significance of other parameters for determining DD, E/e', and LAVI was calculated which also showed significant positive correlation with SS. Abalı *et al*.[15] did not find any correlation of DD with the severity of CAD probably because they evaluated only stable CAD patients, unlike NSTEACS patients in our study.

Diastole is an energy-dependent process, and thus, adequate energy supply must be available for this process to occur. During myocardial ischemia, the energy supply is reduced or abolished. Diastolic function has a lower threshold than systolic function; therefore, DD precedes the onset of systolic dysfunction and persists longer than systolic disturbance in ischemia.[6,16] High myocardial stiffness in ischemic zone is increased with CAD patients. During ischemia, increased myocardial stiffness in addition to a decreased rate of wall thinning and slow active pressure decay contributes to the upward shift in the LV-wall thickness and pressure-volume relationships which lead to an increased susceptibility to LVEDP.[15,17]

DD refers to abnormal mechanical property of myocardium and includes abnormal LV diastolic distensibility, impaired filling, chamber stiffness, and slow or delayed relaxation.[18] In terms of physiology, any mechanism that interferes with actin-myosin cross-bridge detachment or with removing calcium from the cytosol can delay the relaxation. DD is at a higher risk of developing heart failure with preserved ejection factor.[19]

Clinically NSTE-ACS is seen as frequently as STE-ACS and also has a good mortality rate. Creating registry, the largest data from Indian patients with ACS have shown that the pattern of ACS among Indians is much different from that of the Western populations.[10]

Hence, our study was utilized DD as a bedside risk stratification tool for assessing the severity of disease so that we can formulate and strategize the treatment.

Limitations

There are various parameters to assess the DD, but the parameters considered in this study, i.e., E/A, E/e', and LAVI are easily studied in transthoracic echocardiography. We

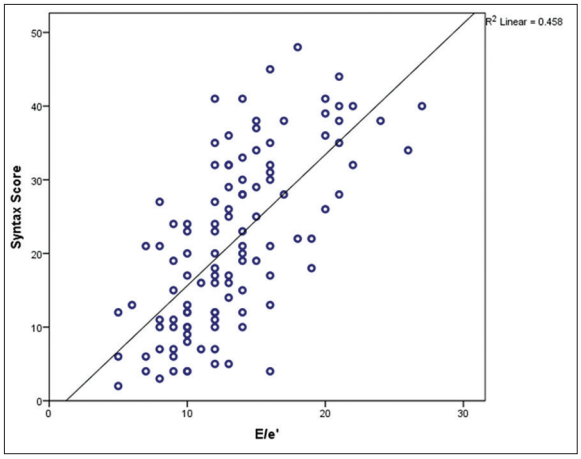

Figure 1: Correlation between SYNTAX score and E/e' ratio

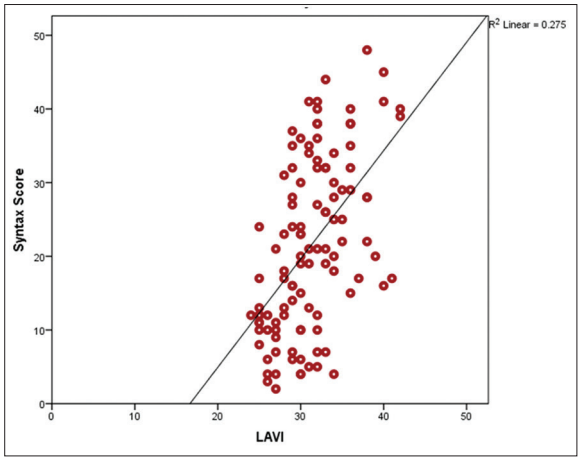

Figure 2: Correlation between SYNTAX score and left atrial volume index

did not evaluate DD by considering other parameters. Our study did not include measurement of parameters of DD by invasive method.

CONCLUSION

The study shows a positive correlation between severity of CAD assessed using SS and E/A and E/e' and LAVI which are various determinants of DD, thereby strengthening the need to consider and include DD in risk stratification of NSTE-ACS patients.

REFERENCES

1. Paul AK, Kusuoka H, Hasegawa S, Yonezawa T, Makikawa M, Nishimura T, *et al.* Prolonged diastolic dysfunction following exercise induced Ischaemia: A gated myocardial perfusion SPECT study. Nucl Med Commun 2002;23:1129-36.
2. Fukuta H, Ohte N, Wakami K, Goto T, Tani T, Kimura G, *et al.* Prognostic value of left ventricular diastolic dysfunction in patients undergoing cardiac catheterization for coronary artery disease. Cardiol Res Pract 2012;2012:243735.
3. Ohara T, Little WC. Evolving focus on diastolic dysfunction in patients with coronary artery disease. Curr Opin Cardiol 2010;25:613-21.
4. Carluccio E, Biagioli P, Alunni G, Murrone A, Leonelli V, Pantano P, *et al*. Effect of revascularizing viable myocardium on left ventricular diastolic function in patients with Ischaemic cardiomyopathy. Eur Heart J 2009;23:ehp125.
5. Chaowalit N, Auesethasak R, Santanakorn Y, Jakrapanichakul D, Kittipovanonth M, Chirakarnjanakorn S, *et al.* Patients with non-sT-segment elevation myocardial infarction present with more severe systolic and diastolic dysfunction than patients with unstable angina. J Med Assoc Thai 2011;94 Suppl 1:S19-24.
6. Zile MR, Brutsaert DL. New concepts in diastolic dysfunction and diastolic heart failure: Part I: Diagnosis, prognosis, and measurements of diastolic function. Circulation 2002;105:1387-93.
7. Zile MR, Brutsaert DL. New concepts in diastolic dysfunction and diastolic heart failure: Part II: Causal mechanisms and treatment. Circulation 2002;105:1503-8.
8. Sahin DY, Gür M, Elbasan Z, Uysal OK, Özaltun B, Şeker T, *et al.* Relationship between myocardial performance index and severity of coronary artery disease assessed with SYNTAX score in stable coronary artery disease. Echocardiography 2013;30:385-91.
9. Møller JE, Pellikka PA, Hillis GS, Oh JK. Prognostic importance of diastolic function and filling pressure in patients with acute myocardial infarction. Circulation. 2006;114:438-44.
10. Misiriya KJ, Sudhayakumar N, Khadar SA, George R, Jayaprakasht VL, Pappachan JM, *et al.* The clinical spectrum of acute coronary syndromes: Experience from a major center in Kerala. J Assoc Physicians India 2009;57:377-83.
11. Pritchett AM, Mahoney DW, Jacobsen SJ, Rodeheffer RJ, Karon BL, Redfield MM. Diastolic dysfunction and left atrial volume: a population-based study. J Am Coll Cardiol. 2005;45:87-92.
12. Hillis GS, Møller JE, Pellikka PA, Gersh BJ, Wright RS, Ommen SR, *et al*. Noninvasive estimation of left ventricular filling pressure by E/e′ is a powerful predictor of survival after acute myocardial infarction. J Am Coll Cardiol 2004;43:360-7.
13. Capodanno D, Capranzano P, Di Salvo ME, Caggegi A, Tomasello D, Cincotta G, *et al.* Usefulness of SYNTAX score to select patients with left main coronary artery disease to be treated with coronary artery bypass graft. JACC Cardiovasc Interv 2009;2:731-8.
14. Du LJ, Dong PS, Jia JJ, Fan XM, Yang XM, Wang SX, *et al.* Association between left ventricular end-diastolic pressure and coronary artery disease as well as its extent and severity. Int J Clin Exp Med 2015;8:18673-80.
15. Abalı G, Akpınar O, Nisanoğlu V, Ilgenli TF. Severity of coronary artery disease and echocardiographic parameters of ventricular diastolic function. Echocardiography 2014;31:809-13.
16. Wan SH, Vogel MW, Chen HH. Pre-clinical diastolic dysfunction. J Am Coll Cardiol 2014;63:407-16.
17. Jamiel A, Ahmed AM, Farah I, Al-Mallah MH. Correlation between diastolic dysfunction and coronary artery disease on coronary computed tomography angiography. Heart Views 2016;17:13-8.

18. Abhayaratna WP, Barnes ME, O'Rourke MF, Gersh BJ, Seward JB, Miyasaka Y, *et al.* Relation of arterial stiffness to left ventricular diastolic function and cardiovascular risk prediction in patients>or=65 years of age. Am J Cardiol 2006;98:1387-92.
19. Ren X, Ristow B, Na B, Ali S, Schiller NB, Whooley MA, *et al.* Prevalence and prognosis of asymptomatic left ventricular diastolic dysfunction in ambulatory patients with coronary heart disease. Am J Cardiol 2007;99:1643-7.

How to cite this article: Mukhopadhyay T, Gupta A, Biswas U, Majumdar B. Severity of coronary artery disease and echocardiographic parameters of ventricular diastolic function in patients with non-ST-elevation acute coronary syndrome. Int J Med Sci Public Health 2019;8(1):86-90.

Source of Support: Nil, **Conflict of Interest:** None declared.