Mitral Annular Systolic Plane Excursion as a Predictor for Severity of Coronary Artery Disease and Left Ventricular Systolic Function in Metabolic Syndrome Patients with Chronic Stable Angina

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Abstract

Background and aim: Coronary Artery Disease (CAD) is the most common type of heart disease. Globally, CAD is the leading cause of death and is predicted to remain so for the next 20 years. Metabolic syndrome is a lethal endocrinopathy starting with insulin resistance and inviting a chain of systemic disorders such as abdominal obesity, glucose intolerance or diabetes mellitus (DM), dyslipidemia, hypertension (HT) and coronary artery disease (CAD). MAPSE has been proposed as a well-established clinically useful echocardiographic parameter for the assessment of LV longitudinal function and correlates with global systolic function of the LV. **Aim**: This study aimed to evaluate the mitral annular systolic plane excursion as a predictor of Left ventricular systolic function and coronary artery disease (CAD) severity detected by coronary angiography (Syntax score) in metabolic syndrome patients with chronic stable angina. **Patients & Methods:** the study was conducted from April 2021 to December 2021, included 50 patients who are diagnosed as Metabolic syndrome patients with chronic stable angina who underwent: 1-transthoracic echocardiography to measure left ventricular systolic function and mitral annular systolic plane excursion by m-mode. 2-Coronary angiography by standard technique and syntax score was assessed. **Results:** The age ranged from 40 to 77 years with a mean value (±SD) of 57.4 ± 9.04 years. There were 33 (66%) male patients and 17 (34%) female patients. As regard risk factors, smoking was in 22 (44%) patients, DM in 26 (52%) patients, hypertension was in 36 (72%) patients and Positive family history was in 27 (54%) patients. The waist circumference ranged from 72 to 100 cm with a mean value (±SD) of 87.48 ± 7.6 cm. Total Cholesterol ranged from 200 to 310 mg/dl with a mean value (±SD) of 225 ± 28.86 mg/dl. Triglycerides ranged from 130 to 210 mg/dl with a mean value (±SD) of 158 ± 17.71 mg/dl. HDL ranged from 30 to 65 mg/dl with a mean value (±SD) of 41 ± 8.35 mg/dl.EF ranged from 50 to 70 % with a mean value (±SD) of 58 ± 6.06 %. MAPSE ranged from 1 to 2 cm with a mean value (±SD) of 1 ± 0.80 cm. There was a strong positive significant correlation between MAPSE and EF of the studied patients. Syntax score ranged from 4 to 47 with a mean value (±SD) of 19 ± 10.47 and median of 15. As regard number of vessels, normal Coronary Angiography was in 1 (2.0%) patient, Atherosclerotic non-significant Coronaries in 13(26.0%) patients, single Vessel CAD was in 13 (26.0%) patients, Two Vessels CAD was in 10 (20.0%) patients and Three Vessels CAD was in 13(26.0%) patients. There was a strong negative significant correlation between MAPSE and Syntax score of the studied patients. MAPSE was significantly lower in obstructive group than non-obstructive group (1.09 ± 0.16 cm vs. 1.3 ± 0.09 cm, P <0.001). **Conclusions:** In metabolic syndrome patients with chronic stable angina, there was a strong positive significant correlation between MAPSE and EF of the studied patients. Also, there was a strong negative significant correlation between MAPSE and Syntax score. Further, MAPSE was significantly lower in obstructive group than non-obstructive group.

Key Words: Mitral annular systolic plane excursion, Metabolic syndrome, chronic stable angina, coronary angiography.

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Introduction

Coronary Artery Disease (CAD) is the most common type of heart disease. Globally, CAD is the leading cause of death and is predicted to remain so for the next 20 years. Each year, approximately 3.8 million men and 3.4 million women die from CAD. In 2021, it is estimated that this disease will be responsible for a total of 11.1 million deaths globally. **(Mathers CD, et al., 2006)**

Metabolic Syndrome (MetS) is basically a cluster of cardiovascular risks that involve changes in metabolic and hemodynamic indicators; various organizations have defined it with small differences. Metabolic syndrome is a lethal endocrinopathy starting with insulin resistance and inviting a chain of systemic disorders such as abdominal obesity, glucose intolerance or diabetes mellitus (DM), dyslipidemia, hypertension (HT) and coronary artery disease (CAD). **(DeryaAtik et al., 2014)**

Left ventricular (LV) longitudinal shortening plays an important role in cardiac pump function and can be evaluated by measuring longaxis,M-mode-derived, mitral annular plane systolic excursion(MAPSE). **(Kai Hu et al., 2018)**. Although good imaging quality is required for most of the modern echocardiographic techniques for reasonable interpretation of LV systolic function, TDI and MAPSE are measurable in the majority of patients quite independent of imaging quality. **(Kai Hu et al., 2018).** MAPSE has been proposed as a well-established clinically useful echocardiographic parameter for the assessment of LV longitudinal function and correlates with global systolic function of the LV. **(Kai Hu et al., 2018)** Coronary angiography continues as a cornerstone in the evaluation of the coronary arteries. SYNTAX score is a scoring system used to estimate the severity of CAD through coronary angiography, on the basis of coronary anatomic risk factors. These factors include: the number of lesions, total occlusion, bifurcation, trifurcation, ostial stenosis, tortuosity, calcification, thrombus, diffuse lesion and small vessel/diffuse disease. **(Anderson RD, et al., 2013).**

Aim of the study

The aim of this study is to evaluate the mitral annular systolic plane excursion as a predictor of Left ventricular systolic function and coronary artery disease (CAD) severity detected by coronary angiography (Syntax score) in metabolic syndrome patients with chronic stable angina.

Patients and Methods:

The present study includes 50patients admitted to Al-Azhar Assuit University Hospital and Sohag Specialized cardiac center for elective CA.

Inclusion criteria:

1-Age: all ages. 2-Sex: both male and female included. 3-Patients with chronic stable angina indicated for coronary angiography according to ACC/AHA guidelines. 4-Metabolic syndrome patients who diagnosed by having 3 at least from these 5 components: 1. Obese patients (waist circumference is more than 102cm in men or 88cm in women). 2. Patients with high triglycerides (equal or more than 150mg/dl, or on medication for high triglycerides) 3. Patients with low HDL levels (lower than 40mg/dl in men or 50mg/dl in women) 4. Elevated blood pressure (systolic >130mm Hg or diastolic >85mm Hg) or on medication. 5. Elevated fasting sugar (equal or more than 100 mg/dl) or on medication.

Exclusion criteria:

1- Congenital heart disease.
2- Cardiomyopathy EF <50%.
3- Valvular heart disease.
4- Post CABG status.
5- Post PCI status.
6- cerebrovascular disease, end stage liver and renal disease.
7- Arrhythmias.

The following done for all patients:

A written informed consent was obtained from every patient before the following:

I-Detailed history:

1-Personal history, 2-Time of admission, 3-Present history: stressing on chest pain & dyspnea; time of onset, frequency, duration, severity, causative & relieving factors, drugs taken and important associated symptoms, 4-Past history: History of hypertension, DM, hyperlipidemia, 5-Tobacco history (current, former or never), 6-Drug history, and 7-Family history of CAD.

II. Clinical evaluation:

All patients were submitted to full clinical evaluation.

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III. Standard ECG:

Using Fukuda 3channels (made in Japan) All patients obtained standard 12 leads ECG. IV. Laboratory investigations: Random blood sugar, Kidney function tests and Lipid profile.

V. Echocardiography:

Transthoracic echocardiography performed with Simens, Dimensions echocardiogram using 3,5 MHz transducer for assessment of: 1-Left ventricular systolic function by motion mode.2-Mitral annular systolic plane excursion by M-mode in apical view. The M-mode cursor should always be aligned parallel to the LV walls. The systolic excursion of mitral annulus should be measured from the lowest point at end-diastole to aortic valve closure

VI. Angiographic analysis:

Was done by using Siemens Artis zee 20×20 Coronary angiography will be performed by the standard technique and the results will be assessed by SYNTAX score.

Results

Our study included 50 Metabolic syndrome patients who complains of chronic stable angina. The age ranged from 40 to 77 years with a mean value (±SD) of 57.4 ± 9.04 years. There were 33 (66%) male patients and 17 (34%) female patients. As regard risk factors, smoking was in 22 (44%) patients, DM in 26 (52%) patients, hypertension was in 36 (72%) patients and Positive family history was in 27 (54%) patients.

Table (1): Patient characteristics of the studied patients (n = 50)

Age (years)	Mean ± SD	57.4 ± 9.04
	Range	40 - 77
Sex	Male	33 (66%)
	Female	17 (34%)
Risk factors	Smoking	22 (44%)
	DM	26 (52%)
	Hypertension	36 (72%)
	Positive family history	27 (54%)

Table 2: Waist circumference (cm) of the studied patients (n = 50)

Waist circumference (cm)	Mean ± SD	87.48 ± 7.6
	Range	72 - 100

The waist circumference ranged from 72 to 100 cm with a mean value (±SD) of 87.48 ± 7.6 cm.

Table 3: Investigations of the studied patients (n = 50)

Total Cholesterol (mg/dl)	Mean ± SD	225 ± 28.86
	Range	200 – 310
Triglycerides (mg/dl)	Mean ± SD	158 ± 17.71
	Range	130 – 210
HDL (mg/dL)	Mean ± SD	41 ± 8.35
	Range	30-65

Total Cholesterol ranged from 200 to 310 mg/dl with a mean value (±SD) of 225 ± 28.86 mg/dl. Triglycerides ranged from 130 to 210 mg/dl with a mean value (±SD) of 158 ± 17.71 mg/dl. HDL ranged from 30 to 65 mg/dl with a mean value (±SD) of 41 ± 8.35 mg/dl.

**Table 4:** Echocardiography of the studied patients (n = 50)

EF (%)	Mean ± SD	58± 6.06
	Range	50 – 70
MAPSE (cm)	Mean ± SD	1 ± 0.80
	Range	1 – 2

EF ranged from 50 to 70 % by M-mode with a mean value (±SD) of 58 ± 6.06 %. MAPSE ranged from 1 to 2 cm with a mean value (±SD) of 1 ± 0.80 cm.

Table 5: Correlation between MAPSE and EF of the studied patients

		EF (%)
MAPSE (cm)	R	0.853*
	P value	<0.001*

There was a strong positive significant correlation between MAPSE and EF of the studied patients.
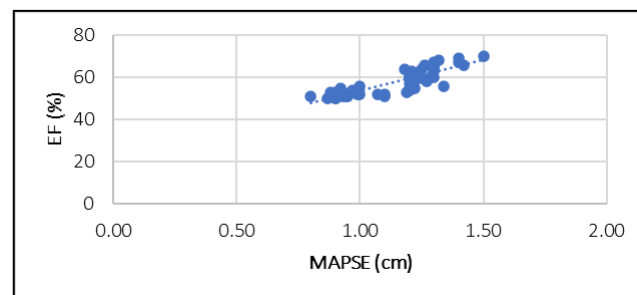
Figure 1: Correlation between MAPSE and EF of the studied patients

As regard number of vessels, Normal Coronary Angiography was in 1 (2.0%) patient, Atherosclerotic non-significant Coronaries in 13(26.0%) patients, single Vessel CAD was in 13 (26.0%) patients, Two Vessels CAD was in 10 (20.0%) patients and Three Vessels CAD was in 13(26.0%) patients.

Table 6: Coronary angiography of the studied patients (n = 50)

Syntax score	**Median**	**15**
	Mean ± SD	**19 ± 10.47**
	Range	**4 – 47**
Number of vessels	**Normal Coronary Angiography**	**1 (2.0%)**
	Atherosclerotic non-significant Coronaries	**13 (26.0%)**
	Single Vessel CAD	**13 (26.0%)**
	Two Vessels CAD	**10 (20.0%)**
	Three Vessels CAD	**13 (26.0%)**

Syntax score ranged from 4 to 47 with a mean value (±SD) of 19± 10.47 and median of 15.

Table 7: Correlation between MAPSE and Syntax score of the studied patients (n = 50)

		Syntax score
MAPSE (cm)	**r**	**-0.859***
	P value	**<0.001***

There was a strong negative significant correlation between MAPSE and Syntax score of the studied patients.
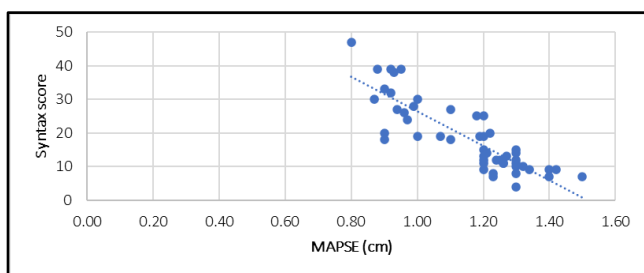
Figure 2: Correlation between MAPSE and Syntax score of the studied patients

Table 8: Relation between MAPSE and type of coronary artery disease

		Obstructive group (n = 14)	Non-obstructive group (n = 36)	P value
MAPSE (cm)	Mean ± SD	1.09 ± 0.16	1.3 ± 0.09	<0.001*

MAPSE was significantly lower in Obstructive group than non-obstructive group (1.09 ± 0.16 cm vs 1.3 ± 0.09 cm, P <0.001).

Discussion

Mitral annular plane systolic excursion (MAPSE) also known as left atrioventricular plane displacement (AVPD), mitral annulus excursion (MAE) or mitral ring displacement is an M-mode derived echocardiographic marker of LV longitudinal function **(Elnoamany & Abdelhameed, 2006).** MAPSE correlates well with other markers of LV function **(Hu et al., 2013)**, is easily obtainable even for the untrained observer and in patients with poor acoustic windows. It has been suggested as a surrogate measurement for LVEF in cardiac patients **(Bergenzaun et al., 2011).**

A reduced MAPSE has been shown to correlate with age, and LV function in patients with myocardial infarction, heart failure and atrial fibrillation and to be more sensitive than conventional echocardiographic markers in detecting abnormalities in LV systolic function at an early stage **(Emilsson & Wandt, 2000)** MAPSE is known to be prognostic for major cardiac events and mortality in patients with cardiovascular disease **(Rydberg et al., 2003).** In critically ill patients there are no reports of the use of MAPSE, its association with other echocardiographic parameters, myocardial injury or clinical outcome **(Brand et al., 2002) (Bergenzaun et al., 2013).**

In our results, MAPSE was significantly lower in obstructive group than non-obstructive group (1.09 ± 0.16 cm vs 1.3 ± 0.09 cm, P <0.001). Similarly, **Sharma et al., (2020)** concluded that normalized MAD (Mitral annular displacement) demonstrated good accuracy in predicting significant CAD in patients with CSAP with normal LVEF and normal WMSI on conventional echocardiography. It has potential of being a robust noninvasive diagnostic tool for detecting CAD and to the very least it shall be of complementary value to other imaging markers when LV curvature is poorly visualized. Further, **Willenheimer et al., (1999)** demonstrated that MAPSE was reduced in 88 out of 1350 consecutive patients with visual evaluated normal LV regional wall motion and these patients with reduced MAPSE had either prior myocardial infarction (60%) or coronary artery disease without infarction (33%), or uncontrolled hypertension (2%) while definitive evidence for cardiovascular diseases was absent in only 4%

patients with reduced MAPSE. This suggests that decreased MAPSE, in the case of normal LV regional wall motion, could serve as an echocardiographic functional sign for myocardial abnormalities, predominantly indicating sub-endocardial dysfunction. Also, he concluded that progressive decrease in AVPD with increasing coronary artery disease was found irrespective of whether or not patients had a diagnosis of prior myocardial infarction. Furthermore, **Willenheimer et al., (2003)** showed that mortality in patients with stable CAD and an abnormal coronary angiogram was strongly related to mean left AVPD, independent of prior myocardial infarction, number of atherosclerotic coronary artery vessels and all other variables. The high discriminative value of AVPD with regard to mortality is clearly shown by the logistic regression analyses. This is further underscored by the box plots, indicating very little overlap with regard to AVPD, between patients who died of a cardiac cause and others. patients with AVPD <10 mm had a cardiac mortality of 21.2%, whereas no patients with AVPD >12.5 mm died. Left AVPD was especially, closely related to cardiac mortality, whereas patients who died of noncardiac causes showed an AVPD similar to that amongst the survivors. Probably, the reason that AVPD is so sensitive to prognosis in these patients is that, as opposed to LVEF, left AVPD seems to be a marker of left ventricular dysfunction even in patients with mild CAD. In patients with CAD, LV dysfunction may depend on several factors such as myocardial infarction, chronic ischaemia causing development of fibrosis, recurrent episodes of myocardial ischaemia causing myocardial stunning and continuously reduced myocardial blood flow leading to hibernating myocardium. EF ranged from 50 to 70 % with a mean value (±SD) of 58 ± 6.06 %. MAPSE ranged from 1 to 2 cm with a mean value (±SD) of 1 ± 0.80 cm. There was a strong positive significant correlation between MAPSE and EF of the studied patients. **Mayr et al., (2020)** findings were in consistent with our results, LVEF was 54.4 [48%–59.6%], in addition, MAPSE was 10.2 mm [8.6–12].

Further, **Grue et al., (2018)** found that EF recorded 38 (30–45) systolic dysfunction patients, and 53 (50–58) in diastolic dysfunction patients. Further, cardiologist reported MAPSE (mm) was 11.9 ± 3.1. **Matos et al., (2012)** studied the predictive value of MAPSE Using the

first 300 studies, an algorithm was developed to predict EF, and concluded that MAPSE measurement was found to be a highly accurate predictor of EF. MAPSE, in addition to being a simple surrogate for EF, may have implications for patient outcomes. **Willenheimer et al., (1999)** demonstrated that among patients with heart failure, those with decreased MAPSE levels had significantly higher mortality; future work should be done in to assess the correlation between MAPSE measurements and patient outcomes. **Hussein (2015)** found that there was a positive significant correlation between the EF% utilizing the Simpson method and MAPSE as regarding males which was the same results in female group and as regard to the Receiver Operating characteristic (ROC) curve showing relationship between sensitivity and specificity of particular cut-off value of MAPSE to diagnose systolic function and its Area Under Curve (AUC = 0.776); and it was significant (p = <0.001). Using 1.21cm or more as a cut-off value in male group in agreements of good systolic function (≥55% EF measured by Simpson) while less than 1.21cm equals poor systolic function, the Sensitivity was 66.67 with Specificity 85.71 with accuracy 73.17.

Conclusion and Recommendations

In metabolic syndrome patients with chronic stable angina, there was a strong positive significant correlation between MAPSE and EF of the studied patients. Also, there was a strong negative significant correlation between MAPSE and Syntax score. Further, MAPSE was significantly lower in obstructive group than non-obstructive group.

We recommend that: 1-Future studies may measure MAPSE with considering factors like patients' size, ventricular diameters, sex, or age that might influence absolute mitral plane motion. 2-MAPSE along with SYNTAX score are helpful in the stratification of CAD severity. 3-MAPSE is a simple, easily acquired, and less time-consuming parameter, especially useful in patients with poor imaging qualities.

Study limitations:

The relatively small sample size of the current study reiterates the need to validate the findings in a larger patient cohort. The duration of metabolic syndrome in our study population was unknown, and it is unclear whether the disease period affects MAPSE. Due to our inclusion criteria, the results of this study only apply to a selected patient group

and must not be generalized for patients with other cardiac pathologies that, for instance, entail left ventricular remodeling.

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