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Correlation of Mitral Annular Plane Systolic Excursion [Mapse] with Left Ventricular Ejection Fraction in Tertiary Care Centre

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Abstract: ***Background: Assessing left ventricular function is a most common indication for echocardiogram. Mitral annular plane systolic excursion (MAPSE) has been used as a substitute measure for left ventricular function. The aim of this study was to evaluate the accuracy of MAPSE for predicting left ventricular function (Ejection fraction) on the basis of a echocardiogram. Methods: The study was designed as a prospective analysis of 250 patients echocardiographic studies performed in a institute. MAPSE measurement was performed and compared with the EF as determined by an echocardiographer. Results: Using the 250 studies, an algorithm was developed to conclude EF. Cutoff value for normal EF (≥13 mm for men and ≥11 mm for women) and decreased EF (For the mid-range MAPSE values. By comparing the predicted EF and the expert-reported EF, positive and negative predictive values, sensitivity (73%–92%), specificity (81%–100%), and accuracy (82%–86%) of MAPSE for predicting EF were calculated. Conclusions: measurement of MAPSE by an observer was found to be a most accurate predictor of EF.***

Keywords: MAPSE, Ejection fraction

1. Introduction

Assessing left ventricular systolic function is a mostly indicated for transthoracic echocardiogram. Left ventricular function is often expressed as an LVEF, which over time has been determined using many methods. Also, assessing LVEF using currently available techniques is mostly dependent on adequate endocardial resolution and the technical quality of the echocardiogram study.

During systole, both longitudinal and circumferential fibers leads to myocardial contraction. Gibson and colleagues have done extensive work studying the importance of longitudinal fiber shortening and its relationship to left ventricular function. He and his colleagues demonstrated that the movement of the mitral annulus toward the apex is a result of long-fiber contraction. During diastole, the annulus moves back away from the apex. Left ventricular apical motion is limited throughout the cardiac cycle, such that the distance between the apex of the heart and the chest surface is almost constant during contraction. The magnitude of the displacement of the mitral annulus during myocardial contraction can be measured from M-mode images of the mitral annulus

Mitral annular plane systolic excursion (MAPSE), also referred to as mitral annular motion or atrioventricular displacement, was measured as early as 1967, when Zaky et al. described a ‘‘curve contour’’ using M-mode echocardiogram through the mitral ring, which measured 1.6 ± 0.4 cm. They found ‘‘deviations’’ from this normal value in the movement of the mitral ring in patients with heart disease. MAPSE more recently has been suggested as a surrogate measurement for left ventricular function. Some have shown linear correlations between expert-measured EF and MAPSE; one study showed that a MAPSE value of <7mm had sensitivity of 92% and specificity of 67% for detecting severe left ventricular dysfunction. A separate study demonstrated that a MAPSE value of <12mm had 90% sensitivity and 88% specificity for detection of EF <50%. Others have shown that MAPSE measurements correlate well with other techniques for left ventricular functional assessment, including three-dimensional echocardiogram and cardiac MRI.10, 11 Tsang et al.12 studied the correlation of MAPSE, as derived from speckle-tracking echocardiogram, with MRI-determined EF. They found a very strong correlation using this alternative MAPSE technique, suggesting a clear relation between mitral annular motion and global left ventricular systolic function.12 Multiple studies have shown that a decrease in MAPSE correlates with many factors affecting left ventricular function, including atrial fibrillation, myocardial infarction, dilated cardiomyopathy, and age.

2. Material & Methods

Setting: department of cardiology, at a tertiary care hospital [RGGGH] in Chennai from JAN-MARCH 2023

Study Design: Observational Study.

Study Period: JAN’ 2023 to MAR’2023. [3 months]

Participants: 250 patients came to cardiac evaluation in department of cardiology.

Method:
Procedure-M-mode echocardiogram through the mitral valve annulus, from the apical four-chamber view, both the lateral and septal annuli, is routinely performed. No specific image orientation was used for the purpose of MAPSE measurement; the images were optimized for routine four-chamber view evaluation. The M-line was pointed through the medial and lateral annulus. The trough of the motion was defined as the end-diastolic position of the annulus, measured at the tip of the QRS complex. The peak was defined as the maximal systolic excursion point. The average MAPSE value (mean of septal and lateral values) was obtained for every patient and used in the analysis. Each study was assesed (clinically) by an expert, providing an **estimation of the EF that was based on the use of Simpson's method**.

Statistical analysis:
The collected data were analysed with IBM SPSS Statistics for Windows, Version 29.0. (Armonk, NY: IBM Corp). To describe about the data descriptive statistics frequency analysis, percentage analysis were used for categorical variables and the mean & S. D were used for continuous variables. To find the significant difference between the bivariate samples in Independent groups the Independent sample t-test was used. The simple linear regression model was used to fit the line of equation. To assess the relationship between the variables Pearson's Correlation was used and represented in Scatter plot. In all the above statistical tools the probability value.05 is considered as significant level.

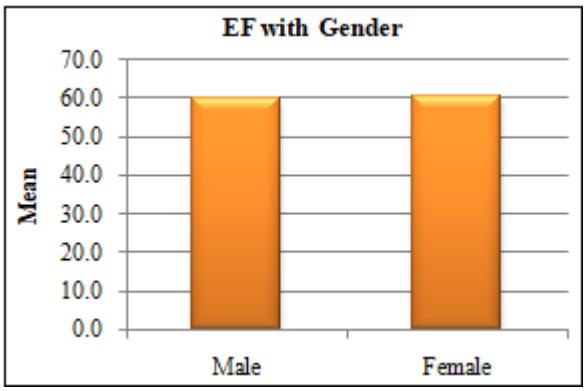
3. Observation & Results

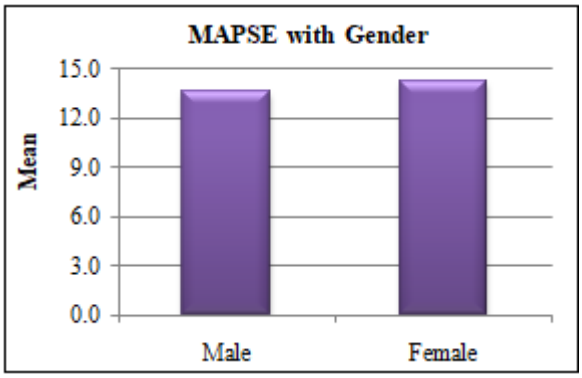
Caliberation cohort:
Our starting analysis of the 250 studies in the calibration cohort showed that MAPSE values ≥ 13 mm in men consistently predicted a normal or increased EF. Similarly, we found that in women, MAPSE values ≥ 11 mm predicted a normal or increased EF. Likewise, we found that a MAPSE value < 6 mm (for both women and men) served as an appropriate cutoff for predicting severely decreased EF (≤30%).

Given these data, we created an algorithm for assesing EF on the basis of MAPSE measurement. For women, a MAPSE value ≥11 mm determined a normal EF (≥55%), while in men, this value was 13 mm. A MAPSE value < 6 mm in either gender was considered to reflect a severely decreased EF (≤30%). A MAPSE measurement between these cutoff values was used in the gender-specific regression equation, and a predicted EF was calculated.

Verification cohort:
To determine the accuracy of our algorithm, absolute variation from expert-reported EF was calculated for every patient. If a patient had a MAPSE value < 6 mm and an EF ≤ 30%, this was considered a direct proportional. In addition, if a female patient had a MAPSE value ≥ 11 mm or a male patient had a value ≥13 mm and the expert-reported EF was normal or increased, this was also considered a concordant one.

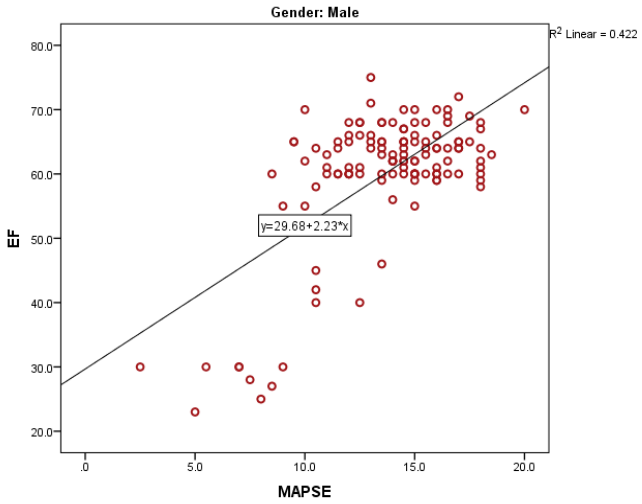
The accuracy of MAPSE < 6 mm for predicting a severely decreased EF was calculated. The PPV was 100% in men and 88% in women. Sensitivity was 73% in men and 100% in women. The PPV for MAPSE > 11 mm in women to predict a normal EF was 94%. Sensitivity for this cutoff value was 92%. The positive predictive value for MAPSE ≥ 13 mm in men to predict a normal EF was 94%. The sensitivity of this cutoff value was the same as the value for women, 92%.

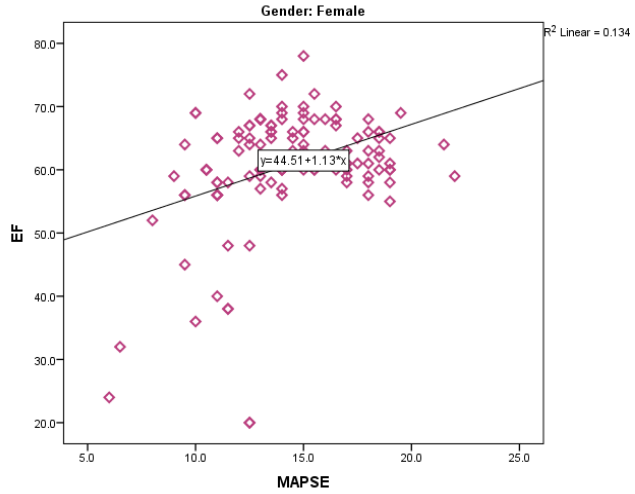




Correlations			
	Gender		MAPSE
EF	Male	r-value	.650**
		p-value	.0005
		N	125
	Female	r-value	.366**
		p-value	.0005
		N	125
** Significant at the 0.01 level.			

The regression model for male is as follows EF = 2.22 * MAPSE + 29.682 with r= 0.650 and for female the model is EF = 1.134 * MAPSE + 44.514 with r = 0.366 and both the models were highly statistical significant





4. Discussion

Our results demonstrate that MAPSE values are accurate predictors of left ventricular EF. We verified this in a large cohort of consecutive patients (250) with no exclusion criteria, representative of what might be seen in any busy echocardiography laboratory.

We created a simple algorithm for the prediction of EF on the basis of MAPSE values; high and low cutoff values determine normal and severely reduce EF.

MAPSE is a very simple M-mode measurement that is almost independent of image quality for its accuracy. This was demonstrated in our study.

A new finding noted in our calibration and verification cohorts was the difference in MAPSE values between men and women. For a given MAPSE value, the correlating EF was higher for women than for men. Otherwise stated, for a given EF, women had lower MAPSE values than men. Villari et al found that for a similar degree of aortic stenosis, women had higher EFs than men, while myocardial stiffness constant was found to be higher in men than women. In addition, previous work has shown that a larger heart size correlates with a larger MAPSE for a given EF. Because women's hearts are typically smaller than men's, the mitral annulus has a shorter distance to travel toward the apex during systolic motion. This could account (at least partially) for the observed differences between men and women and explain why the threshold for a normal MAPSE for women should be lower than that of men.

MAPSE, in addition to being a simple surrogate for EF, may have additional implications for patient outcomes. Willenheimer et al demonstrated that among patients with heart failure, those with decreased MAPSE levels had significantly higher mortality. MAPSE may also detect pathology other than a depressed EF. Wenzelburger et al. demonstrated that MAPSE values are decreased in patients with heart failure with preserved EF versus normal control.

5. Conclusions

Our work has determined that MAPSE, is a viable substitute for expert determined left ventricular EF. Our findings suggest that gender significantly affects this correlation. We have established upper and lower thresholds for normal and severely reduced EFs for each gender and a simple gender specific equation to calculate EF from intermediate MAPSE values. We believe that MAPSE should be routinely acquired in all echocardiographic studies and used as a surrogate for global left ventricular EF.

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