



## ASSESSMENT OF LEFT VENTRICULAR FUNCTION USING MITRAL ANNULAR PLANE SYSTOLIC EXCURSION/LEFT VENTRICULAR LENGTH AND GLOBAL LONGITUDINAL STRAIN IN HEART FAILURE PATIENTS

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### ABSTRACT

**Introduction:** Evaluation of ventricular function especially longitudinal parameters like Mitral annular plane excursion, holds significant importance in the timely identification of myocardial dysfunction.

While mitral annular plane systolic excursion (MAPSE) provides a straightforward means of measuring and quantifying the LV function, its reliability can exhibit variations among individuals with heart failure, dilated hearts, and across genders. Therefore, considering the ratio of MAPSE to left ventricular diastolic length as a potential parameter for evaluating LV function in heart failure patients could offer enhanced reliability. This ratio may provide a standardized measure, accounting for individual differences in LV size and shape, thereby potentially improving the accuracy of longitudinal LV function assessment, particularly in patients with diverse clinical characteristics. Overall, integrating the MAPSE/left ventricular length ratio into routine practice has the potential to augment the LV function assessment, particularly in the context of heart failure management. **Aims and Objectives:** To assess the left ventricular systolic function using Mitral annular plane systolic excursion/left ventricular length and Global Longitudinal Strain in heart failure patients. **Materials and Methods:** A total of 42 adult participants who were admitted in Cardiac ICU, Emergency room and arriving in cardiac OPD with Left ventricular dysfunction were included in the study. Using echocardiography MAPSE, LV length, Ejection fraction, Global longitudinal strain was measured, MAPSE/LV length was measured and using SPSS 26.0, Pearson correlation was measured between MAPSE/L and GLS. **Results:** In heart failure patients, comparison of MAPSE/L and GLS were done and it is found to have strong correlation between the 2 parameters. Even with the widespread adoption of advanced echocardiographic technologies, the MAPSE/L ratio is anticipated to provide a straightforward parameter that remains valuable for assessing and quantifying the Left ventricular systolic function during routine evaluation with the help of Echocardiogram.

**KEYWORDS :** MAPSE-Mitral Annular Plane Systolic Excursion GLS-Global longitudinal strain EF- Ejection fraction EDV- End-diastolic volume ESV- End-systolic volume

### INTRODUCTION

#### Heart Failure

Heart failure (HF) is a condition in which myocardium is unable to meet the metabolic demands of the body by supplying required oxygenated blood and resulting in various symptoms and signs of heart failure. This condition can result from structural or functional abnormalities of the heart, particularly affecting the left ventricle. HF is usually the result of changes in LV geometry and mechanics, including dilation, hypertrophy, and impaired myocardial contractility.[1][2]

#### Deformation of Myocardium Due to Heart Failure[1][3]

In HF, the myocardium undergoes pathological changes that result in altered mechanical properties. These changes include fibrosis, myocyte hypertrophy, and altered extracellular matrix composition, leading to reduced myocardial compliance and contractility.

#### Ejection Fraction[4]

Ejection fraction (EF) is measured using the formula  $EF = (EDV - ESV) / EDV \times 100$

EDV - end-diastolic volume, ESV -- end-systolic volume. Various imaging modalities, such as echocardiography, Cardiac magnetic resonance imaging (MRI), and radionuclide ventriculography, are utilized to measure EF. An EF below 40-50% typically indicates systolic dysfunction, which is a hallmark of myocardial failure.

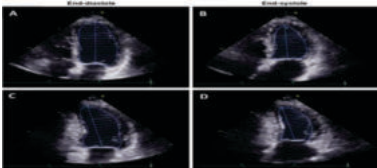


Figure 1: Modified Simpson's Method Echocardiography (Sources:www.mdpi.com)

#### Mitral Annular Plane Systolic Excursion (MAPSE) [5]

MAPSE measures the movement of the mitral annulus towards the apex during the ventricular systolic phase and is a simple yet effective parameter for evaluating longitudinal LV function. Reduced MAPSE values are associated with impaired LV function and worse clinical outcomes in heart failure patients.

#### Myocardial Strain Imaging [6]

Myocardial strain imaging provides a comprehensive assessment of myocardial deformation, offering detailed insights into both global and regional LV function.

In this modality, myocardial strain is calculated as the percentage of distortion in the length of myocardial fibers during the cardiac cycle, which can be categorized into three main types.

- 1. Longitudinal Strain:** Longitudinal strain evaluates the contraction of the myocardium along the length of the heart, from the base to the apex. Global longitudinal strain (GLS) represents the mean strain value across various segments of the left ventricle (LV), serving as a highly sensitive indicator of systolic performance. A decrease in GLS is strongly associated with negative outcomes in heart failure patients.
- 2. Circumferential Strain:** Evaluates the shortening of the myocardium in a circumferential direction around the LV. It provides information about the uniformity of myocardial contraction.
- 3. Radial Strain:** Measures the thickening of the myocardium during systole, offering insights into the inward motion of the ventricular walls.

#### Global Longitudinal Strain (GLS) [7]

It specifically looks at how much the LV shortens from its base

(bottom) towards the apex (tip) during a heartbeat. The LV myocardium experiences complicated deformation during both systole and diastole as a result of contraction and relaxation of different groups of fibers.

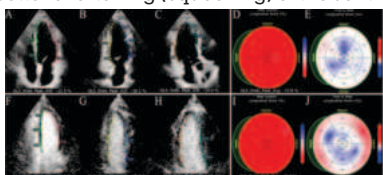
$$\text{STRAIN} = (\text{L-LO})/\text{LO}$$

- LO — Final length (resting state of myocardium length at end systole).
- L — Initial length (resting state of myocardium length at end diastole).

As LV contracts myocardium fiber, shortens in longitudinal and circumferentially (reflects the negative strain) and lengthens in radially (reflects the positive strain). From ECG gated A4c, A2c, A3e, echocardiographic views Image was selected and ACMQ (cardiac motion) application was used. The LV is divided into sections, and GLS is measured in each one. An average value is then calculated to give a global picture of LV function.

Early detection of GLS can detect subtle changes in heart function even before symptoms develop in people at risk of heart problems. Studies have shown GLS to be a more consistent measurement than EF. Reduced GLS is a significant indicator of a higher risk of complications in heart failure patients.

GLS is expressed as a percentage, with a normal range typically between -16% and -24%. A more negative value indicates better shortening (squeezing) of the ventricle.



**Figure 2: GLS Strain Echocardiography** (Sources: cardiovascularultrasound.biomedcentral.com)

Our hypothesis proposed that expressing MAPSE as a percentage of the left ventricle's (LV) long axis shortening. (MAPSE/L) could serve as a more practical echocardiographic parameter for heart failure patients. To investigate this, our study normalized MAPSE by dividing it by the LV length (MAPSE/L) in patients with heart failure. We then explored the relationship between MAPSE/L and various clinical and echocardiographic parameters. Recognizing GLS as a well-established measure of cardiac function, we also assessed the correlation between MAPSE/L and GLS in heart failure patients. This study aimed to determine the potential of MAPSE/L as a marker of cardiac function, especially in comparison to GLS.

### Correlation Between MAPSE and GLS

MAPSE, measured using M-mode echocardiography, and GLS, assessed through speckle tracking echocardiography, both provide valuable insights into LV longitudinal function. Several studies have explored this relationship, highlighting its clinical significance. [8][9]

### Fundamental Relationship

MAPSE and GLS both evaluate LV systolic function but from slightly different perspectives. During systole, the mitral annulus moves toward the apex of the heart, and the extent of this movement can provide valuable insights into the overall systolic function and health of the left ventricle, while GLS assesses the percentage of myocardial fiber shortening along the longitudinal axis of the heart. Despite these differences, both parameters reflect the longitudinal function of the LV.

### Clinical Implications

Studies have shown that there is a strong correlation between MAPSE and GLS in various patient populations, including

those with heart failure. This relationship suggests that both parameters can be useful in evaluating LV function, with MAPSE offering a simpler and more accessible measurement in certain clinical settings.

### Heart Failure

In heart failure patients, MAPSE is frequently reduced even if the left ventricular ejection fraction (LVEF) is within normal limits. This reduction in MAPSE correlates with impaired GLS, indicating that both parameters can detect subtle changes in LV function that are not evident through ejection fraction alone.

## AIM AND OBJECTIVE

### Aim

To assess the left ventricular systolic function using Mitral annular plane systolic excursion/left ventricular length and Global Longitudinal Strain in heart failure patients.

### Objectives

To find correlation between Mitral annular plane systolic excursion/left ventricular length and Global longitudinal strain in patients with heart failure

## METHODS

A Prospective observational study on assessment of left ventricular function using Mitral annular plane systolic excursion/left ventricular length and Global Longitudinal Strain in heart failure patients. A total of 42 subjects were included in the study who presented to our Cardiology department with LV Dysfunction. MAPSE, end diastolic length, Ejection Fraction (EF%), MAPSE/L, GLS were measured. All patients aged >20 years with LV dysfunction in Echocardiography, were included in the study. We have excluded patients with Arrhythmias, pregnancy, poor echo window, psychiatric issues. Using conventional echocardiography ECG gated 2D, M-mode, speckle tracking technique will be done using the Philips affinity 50C machine in Department of Cardiology. The standard PLAX, PSAX, A4c, A2c, A3c, Subcostal view will be recorded. In echocardiography, the LV systolic Function assessed by following echo techniques. Ejection fraction with Modified Simpson's Biplane method, Global longitudinal strain, MAPSE.

## RESULTS

**Table 1: Patient Demography**

Age	subjects	percentage
35-50 years	8	19.2%
51-60 years	18	42.9%
More than 60	16	38.1%

**Table 2: Classification According to LV Function**

LV Function	Subjects	Percentage
Mild (>40%)	17	40.5%
Moderate (30-40%)	16	38.1%
Severe (<30%)	9	21.4%

**Table 3: MAPSE Among Patient Population**

MAPSE (cm)	Subjects	Percentage
<0.8 cm	7	16.7%
0.8-1.2cm	25	59.5%
>1.2 cm	10	23.8%

**Table 4: MAPSE and MAPSE/L Among Patient Population**

MAPSE (cm)	Subjects	MAPSE/L MEAN ± SD
<0.8cm	7	0.08±0.01
0.8-1.2cm	25	0.13±0.01
>1.2	10	0.17±0.02
Total	42	0.13±0.03

**Table 5: GLS Among Patient Population**

GLS (%)	Subjects	Percentage
< -10	7	16.7
-10 – (-16)	29	69.0
>-16	6	14.3

**Table 6: MAPSE, MAPSE/L, EF with GLS Among Patient Population**

Variables	Correlation	Coefficient determination	P- value
MAPSE/L GLS	0.778	0.606	<0.001
MAPSE GLS	0.80	0.652	<0.001
EF (%) GLS	0.7	0.490	<0.001

**DISCUSSION**

In this study, 42 patients with heart failure have been evaluated. Among 42 patients, they were differentiated according to various age group, the majority of patients was between 51-60 years of age (42.9%), 35-50 years of age (19.2%), >60 years of age (38.1%), Table 1.

In 42 patients, 40.5% Patients had Mild LV function, 38.1 % had Moderate LV dysfunction and 21.4% had Severe LV dysfunction, Table 2

Among patient population 25 patients (59.5%) had MAPSE in the range of 0.8-1.2 cm and 7 patients had MAPSE <0.8 cm and 10 patients had MAPSE >1.2 cm. Table 3

Average MAPSE/L (Mitral annular plane systolic excursion/ Diastolic length) was 0.13 to 0.03. In patients with MAPSE of <0.8cm, 0.8 - 1.2 cm, >1.2 cm, the average MAPSE/L was 0.08±0.01, 0.13±0.01, 0.17±0.02 respectively, Table 4

Among Our study population, 7 patients (<16.7%) had GLS <-10%, 29 patients (69%) had GLS of -10(-16) %, and 6 patients (14.3%) had GLS of >-16%. Both MAPSE/L and MAPSE have strong correlation with GLS (correlation coefficient of 0.778 and 0.80 respectively), Table 5

Studies have shown a strong correlation between MAPSE and Left Ventricular Ejection Fraction (LVEF), with reported correlation coefficients (r) ranging from 0.55 to 0.95.

Interestingly, MAPSE has demonstrated comparable efficacy to Global Longitudinal Strain (GLS) in identifying early LV dysfunction. This finding aligns with previous research indicating a positive relationship between MAPSE and GLS measurements.[10] Our study also found a good correlation between MAPSE with LVLS. In a study focused on employing MAPSElat (Mitral Annular Plane Systolic Excursion lateral) normalized by left ventricular length (MAPSE/L) as an indicator of left ventricular (LV) longitudinal function in a group of children, where accounting for age-related changes in ventricular length is essential, researchers discovered a moderate correlation between Global Longitudinal Strain (GLS) and MAPSElat/L.[11]

In our study both MAPSE and MAPSE/L demonstrated very strong correlation with GLS. We assumed that LV length may vary among genders and patients with heart failure, so LV length may affect MAPSE value. We also demonstrated the average MAPSE/L values was 0.13±0.03 among patients. In patients with MAPSE of <0.8cm, 0.8 -1.2 cm, >1.2 cm, the average MAPSE/L was 0.08±0.01, 0.13±0.01, 0.17±0.02 respectively, MAPSE/L had good correlation with GLS at different ranges of MAPSE. So MAPSE/L can be a useful indicator in assessing LV function, depicted in Table 6.

**CONCLUSION**

Correlation Between MAPSE/L and GLS in Heart Failure: our study involving heart failure patients has demonstrated a strong correlation between MAPSE/L and GLS. This suggests that both methods provide comparable information about the LV's longitudinal systolic function.

MAPSE/L: A Valuable Tool Despite Technological

Advancements: Despite the growing adoption of sophisticated echocardiographic techniques, the MAPSE/L ratio is expected to remain a valuable and straightforward parameter for assessing LV longitudinal systolic function during routine echocardiographic examinations. This is due to its simplicity and wide availability.

**Limitations**

It's essential to note that MAPSE/L doesn't assess segmental LV function, limiting its ability to represent overall LV function in individuals with localized myocardial issues. Additionally, the assessment of MAPSE/L doesn't consider the translational motion of the entire heart. This limitation is particularly relevant in cases involving a mobile apex, such as those with substantial pericardial effusion, where caution is warranted in interpreting MAPSE/L values. It's a single-centered study with limited subjects.

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