Original Article

Selvester QRS Score to Quantify the Extent of Myocardial Infarction in Patients with Anterior Myocardial Infarction and Its Correlation with Left Ventricular Function

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Abstract

Background: The degree of left ventricle myocardial scarring in individuals with anterior myocardial infarction (MI) has a poor prognosis because it leads to worsening of left ventricular (LV) systolic and diastolic performance. **Objectives:** To assess the Selvester score's applicability in quantifying the extent of myocardial infarction, and its relationship with systolic and diastolic LV function. **Materials and Methods:** A total of 50 individuals with anterior myocardial infarction participated in this cross-sectional study. The Selvester QRS score was calculated from the quantitative analysis of the 12-lead electrocardiogram (ECG) to determine the extent of the LV infarct. Two and three dimensional echocardiographic (2D and 3D-Echo) assessments were done for all patients to measure the left ventricular systolic and diastolic functioning. **Results:** The Selvester scores of all participants varied from 1 to 15, with a mean equal to 6.1 ± 3.51 points, and the extent of the LV infarct ranged from 3% to 45%, with a mean of 20% $\pm$ 0.09389. Correlation studies of LV infarct size with LV diastolic and systolic parameters revealed a statistically significant positive correlation with E/e' ($P = 0.004$), a statistically significant negative correlation with 2,3D-ejection fraction (P = 0.004, 0.000, respectively), and a statistically significant positive correlation with 3D-sphericity index ($P = 0.04$). **Conclusion:** Selvester scoring can be used in the assessment of infarct size in anterior MI patients, and could additionally reflect the degree of systolic and diastolic LV dysfunction from the significant correlation results of this study, so it could be considered a part of the routine evaluation of ECGs in these patients.

Keywords: Anterior myocardial infarction, ejection fraction, Selvester score

Introduction

The Selvester score translates subtle variations in ventricular depolarization measured by the ECG into information regarding the location and size of myocardial scars, it is computed from variation in the Q and R wave durations, both R and S wave amplitudes, and R/Q and R/S ratios, and it reflects the severity of damage to the myocardium in myocardial infarction (MI) patients.[1] It can be measured using modified criteria for each of the following disorders: left bundle branch block (LBBB), right bundle branch block (RBBB), left anterior fascicular block (LAFB), LAFB with RBBB, left ventricular (LV) hypertrophy, and no confounders.[2] This score of 32 points constitutes a collection of criteria that can be used to locate and assess the extent of the left ventricular myocardial scars, each point accounts for 3% of the left ventricle's myocardial scar area.[3] According to the research, the Selvester score can be used to measure the amount of left ventricular myocardial scarring.[4,5]

Aim of the study

To assess the Selvester score's applicability in quantifying the amount of myocardial infarction, and its relationship with systolic and diastolic LV function.

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Materials and Methods

This cross-sectional study involved 50 patients diagnosed with old anterior myocardial infarction (41 male patients and 9 female patients), ranging in age from 35 to 60 years. This study was conducted in Shaheed Almehrab cardiac catheterization center and Merjan Medical City in Al-Hilla City, through the period from September 2022 until February 2023. The study was done using echocardiography (GE Vived E9 XDclear Ultrasound Machine). 2D, 3D, and Doppler images were taken for all patients.

In an apical 4-chamber view, left ventricular EF was calculated by the Simpson method [Figure 1]. At the mitral valve's leaflet tips, pulsed wave Doppler was used to detect the *E* wave. The *E*/*e′* ratio was computed by tissue Doppler imaging, where sample volume was placed at the mitral annulus from both the septal and lateral sides, as shown in Figure 2.

The 4D auto left ventricular quantification (LVQ) program was used for measuring three dimensional left ventricular EF and SI. The LV is typically recorded as a full-volume dataset over four heartbeats (a multi-beat acquisition) [Figure 3].

Ten electrodes were used for the ECG recording, six of which were attached to the chest and four of which were applied to the limbs by ECG guided acquisition. The ECG was obtained at a velocity of 25 mm/s and with an amplified value of 10 mm/mV.

The ECGs were classified according to the type of ventricular conduction or hypertrophy (LBBB, LAFB, LVH, RBBB, RBBB + LAFB, and non-confounding factors). When lead V1 experienced a negative deflection (rS or Q morphology), the analysis was conducted as shown in Figure 4 and when lead V1 experienced a terminal positive deflection, the analysis was performed in accordance with Figure 5.[1]

After the conduction type was determined, all ECGs were examined for the existence of right atrial overload

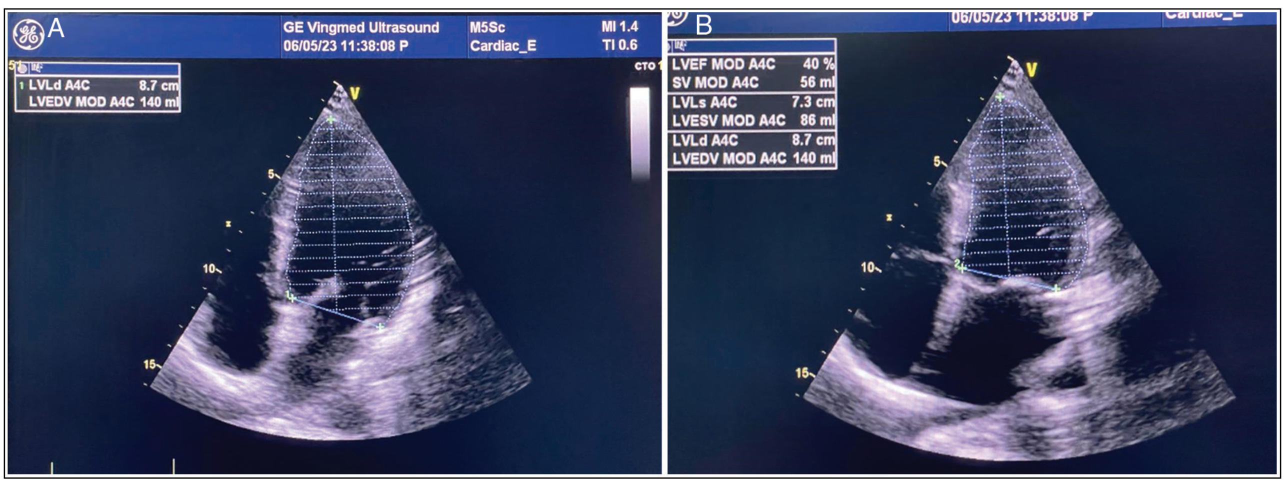


Figure 1: Measurement of ejection fraction by Simpson method (A) at the end diastolic and (B) at the end systolic

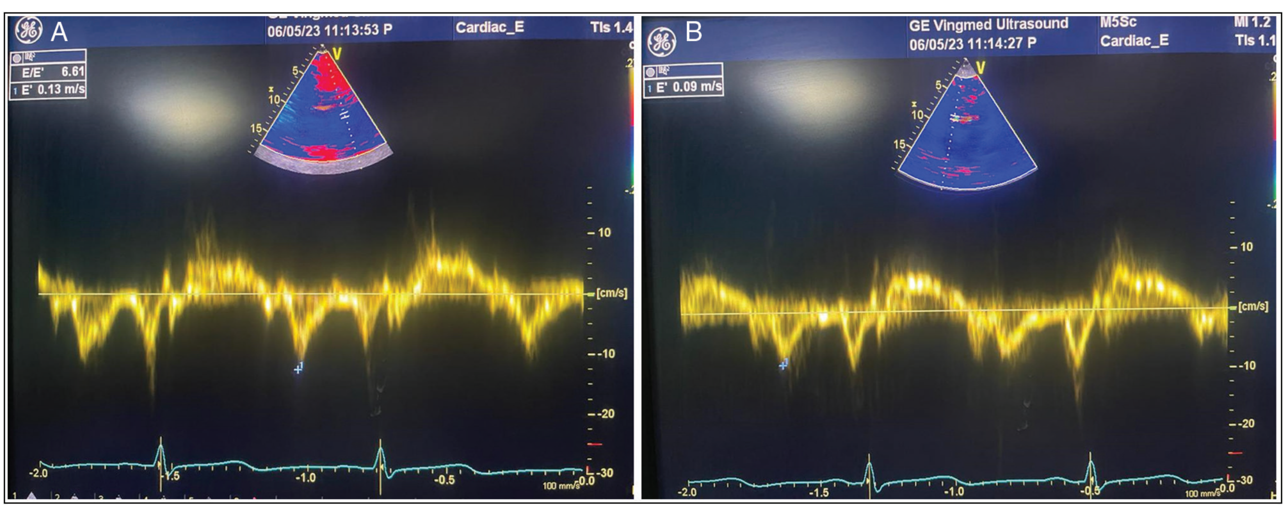


Figure 2: Pulsed tissue Doppler imaging (A) at the lateral and (B) at the septal mitral annulus demonstrate *e*' and *a*' waves

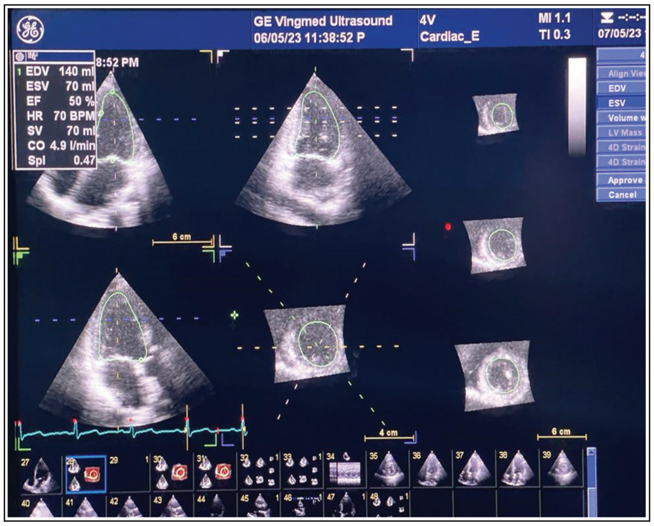


Figure 3: Measurement of ejection fraction and sphericity index by 3D echocardiography

by evaluating the P waves in V1 and aVF, as shown in Figure 6.

The amplitudes and durations were then measured. Additionally, weighing and selection were carried out, in that the former indicate the number of points awarded for each satisfied criterion, while the latter describes the process of selecting one criterion from a group. Only the first satisfied criterion should be chosen in each box [Figure 7].[1]

Statistical analysis

Statistical Program for Social Science (SPSS, 23.0 for windows; SPSS Inc., Chicago, IL, 2015) was used to analyze the obtained data, and all results were represented as the mean along with the standard deviation. An independent t-test was used for comparing continuous variables. Pearson's (r) correlation coefficients were used to assess the relationship between different variables. The P value of 0.05 is regarded as statistically significant.

Ethical approval

This study received approval from the University of Babylon, College of Medicine's publishing ethics committee, and verbal consent from the participants, with approval number 223 was obtained at August 12, 2022.

Results

The Selvester scores of all participants varied from 1 to 15, with a mean equal to 6.1 ± 3.51 points, and the extent of the LV infarct ranged from 3% to 45%, with a mean of 20% ± 0.09389. The mean of 2D, 3D-EF was 40% ± 0.09, 36% ± 0.09, respectively. The mean of *E*/*e*' was 13.03 ± 7.9 [Table 1]. Correlation studies of LV infarct size with LV diastolic and systolic parameters revealed a statistically significant positive correlation with *E*/*e*′ (P = 0.004, r = 0.411) [Figure 8], and a significant negative correlation with 2,3D–EF (for 2D-EF P = 0.004, r = 0.41, for 3D-EF P = 0.000, r = 0.555) [Figure 9]. Also showed a statistically significant positive correlation with 3D-SI (P = 0.04, r = 0.343) as demonstrated in Figure 10.

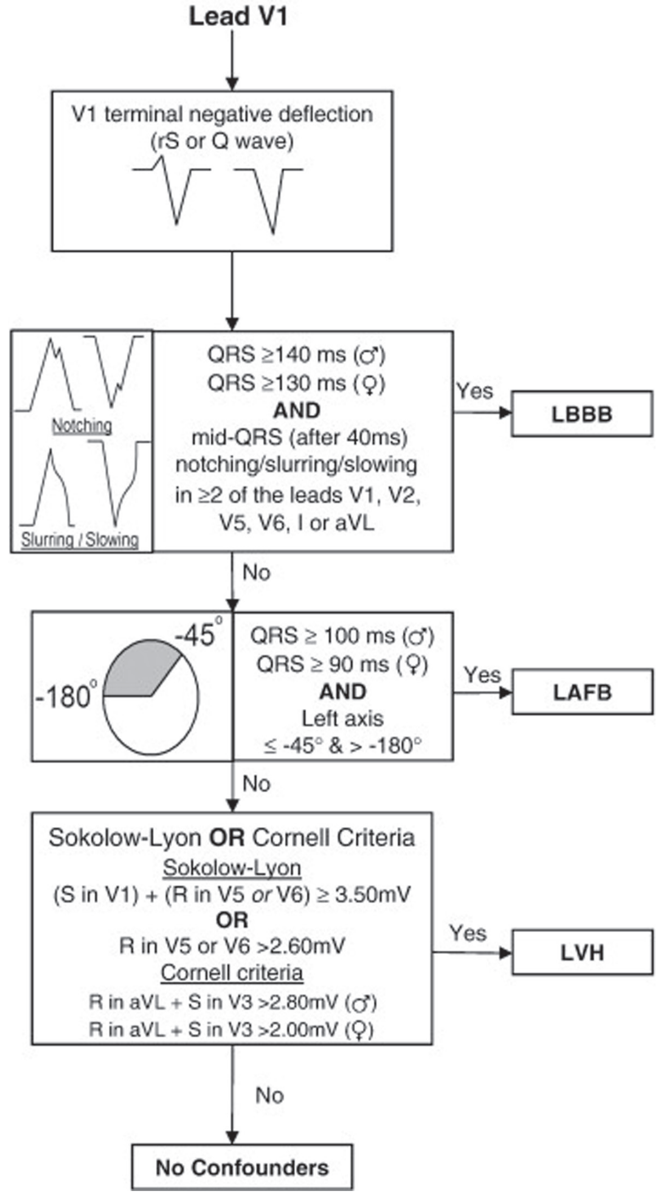


Figure 4: A chart that determines the type of conduction when the major wave of the QRS is downward. Where ECG stands for electrocardiogram, LAFB stands for left anterior fascicular block, and LBBB is for left bundle branch block

Discussion

In this study, the Selvester score was distributed within a comparatively medium score index. This is closer to the Holmes *et al.*[6] study, in which the Selvester score fell within the medium score index. This classification is based on a prior study conducted by Tjandrawidjaja *et al.*,[7] who

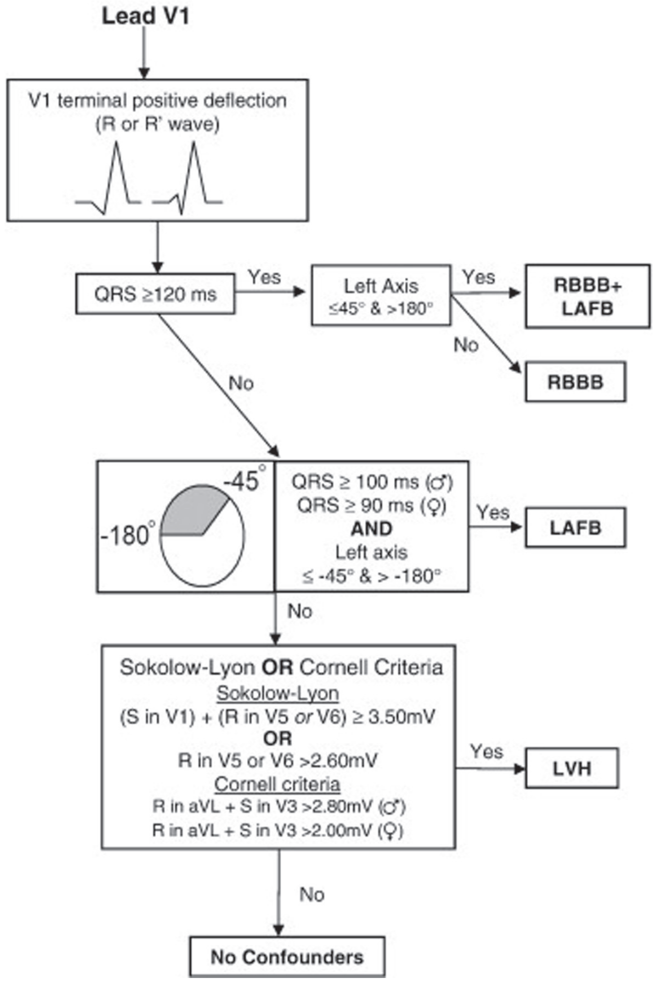


Figure 5: A chart that determines the type of conduction when the major wave of the QRS is upward. Where ECG stands for electrocardiogram, LAFB stands for left anterior fascicular block, and RBBB is for right bundle branch block

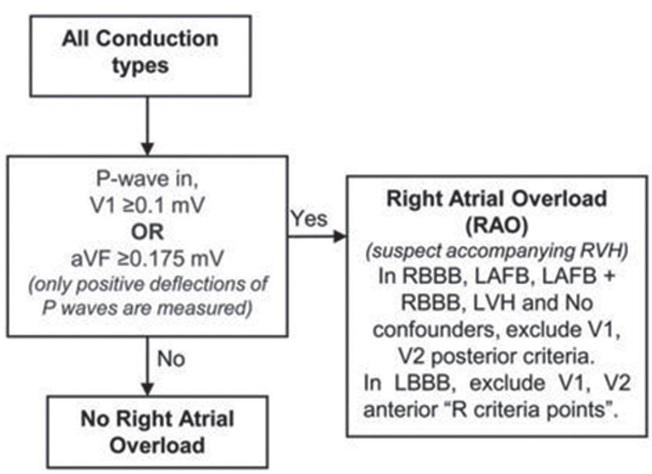


Figure 6: A chart for identification of right atrial overload[3]

classified infarct size as small infarct if the score is 3, medium infarct if the score is 4–7, and large infarct if the score is 8.

As documented previously, the most accurate and repeatable method for determining viability is cardiac magnetic resonance (CMR), the evaluation of scar extent and size using CMR is precise and reproducible.[8] According to studies, the Selvester score and CMR have a strong correlation for assessing the magnitude of an infarct.[6,9]Thus, this could reflect the applicability of the Selvester score in reflecting infarct size.

In this study, a statistically significant positive correlation was found between LV infarct size and *E*/*e*′ and a statistically significant negative correlation with 2,3D-EF. This might be due to the fact that following MI, there was impaired relaxation and stiffness that resulted from collagen accumulation in tissue that altered the elasticity of the myocardium, whenever the infarct size is enlarged, more diastolic and systolic impairment results.

This supports the findings of a previous study that used the myocardial performance index (MPI), as a parameter for systolic and diastolic cardiac functions, the study found that anterior MI patients with a high Selvester score had worse MPI, and the Selvester score and MPI had a strong correlation.[10]

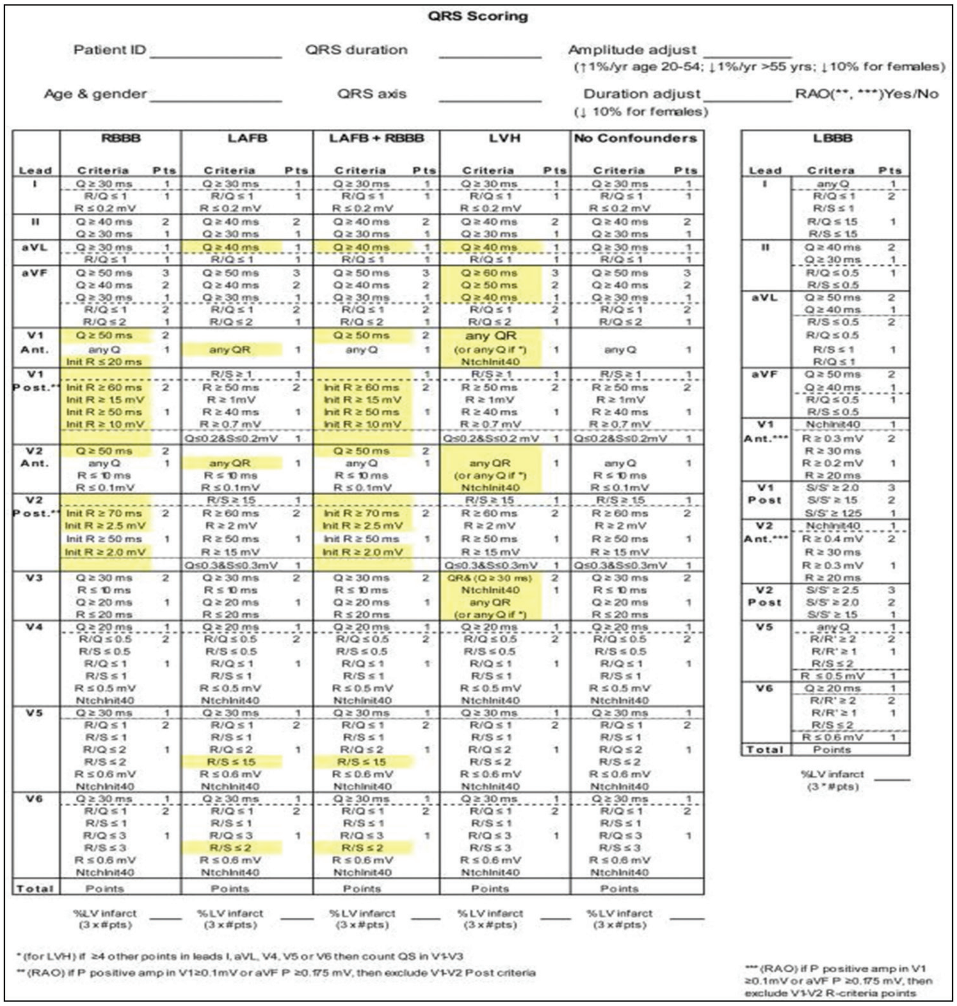
Søholm *et al.*[11] revealed that after MI, the diastolic dysfunction, as a result of increased LV filling pressure, and the systolic dysfunction had a statistically significant correlation with large infarct size, and demonstrated that the systolic dysfunction after MI is linked with a large area of myocardial edema and necrosis that lead to the greater myocardial infarct area. Also, it is in line with the finding of Behairy and his colleagues, who found a significant positive correlation between ischemic heart disease (IHD) patients' levels of myocardial scarring and diastolic dysfunction as measured by CMR.[12]

In contrast, LV diastolic performance and the degree of myocardial scarring had a weak or insignificant correlation, and this was explained by the hypercontractility of the non-infarcted region of the myocardium contributing to preserving the diastolic function.[13,14]

Patients with a higher Selvester score had a considerably lower EF, higher troponin levels, higher damage to the left anterior descending artery, as well as greater adverse events.[15] In a patient with ischemic cardiomyopathy (ICM), the magnetic resonance imaging (MRI) infarct scar score was found to be an independent forecaster of improved LVEF following therapy since it was higher in patients with a substantial drop in EF.[8]

This result showed a statistically significant positive correlation of LV infarct size with 3D-SI. Heusch *et al.*[16] showed that LV remodeling and heart failure after MI are substantially correlated with the extent of the myocardial infarct. Patients with anterior MI experienced a larger infarction due to more at-risk myocardium, as well as more substantial post-infarction remodeling and dysfunction.[17]

In contrast, Pezel *et al.*[18] demonstrated that there was no significant relationship between sphericity index and LV infarct size, both measured by MRI. In Iraq, the lack



QRS Scoring

Patient ID ____________ QRS duration ____________ Amplitude adjust ____________
(↑1%/yr age 20-54; ↓1%/yr >55 yrs; ↓10% for females)

Age & gender ____________ QRS axis ____________ Duration adjust ____________ RAO(**, ***)Yes/No
(↓ 10% for females)

	RBBB		LAFB		LAFB + RBBB		LVH		No Confounders	
Lead	Criteria	Pts	Criteria	Pts	Criteria	Pts	Criteria	Pts	Criteria	Pts
I	Q ≥ 30 ms	1	Q ≥ 30 ms	1	Q ≥ 30 ms	1	Q ≥ 30 ms	1	Q ≥ 30 ms	1
	R/Q ≤ 1	1	R/Q ≤ 1	1	R/Q ≤ 1	1	R/Q ≤ 1	1	R/Q ≤ 1	1
	R ≤ 0.2 mV		R ≤ 0.2 mV		R ≤ 0.2 mV		R ≤ 0.2 mV		R ≤ 0.2 mV	
II	Q ≥ 40 ms	2	Q ≥ 40 ms	2	Q ≥ 40 ms	2	Q ≥ 40 ms	2	Q ≥ 40 ms	2
	Q ≥ 30 ms	1	Q ≥ 30 ms	1	Q ≥ 30 ms	1	Q ≥ 30 ms	1	Q ≥ 30 ms	1
aVL	Q ≥ 30 ms	1	Q ≥ 40 ms	1	Q ≥ 40 ms	1	Q ≥ 40 ms	1	Q ≥ 30 ms	1
	R/Q ≤ 1	1	R/Q ≤ 1	1	R/Q ≤ 1	1	R/Q ≤ 1	1	R/Q ≤ 1	1
aVF	Q ≥ 50 ms	3	Q ≥ 50 ms	3	Q ≥ 50 ms	3	Q ≥ 60 ms	3	Q ≥ 50 ms	3
	Q ≥ 40 ms	2	Q ≥ 40 ms	2	Q ≥ 40 ms	2	Q ≥ 50 ms	2	Q ≥ 40 ms	2
	Q ≥ 30 ms	1	Q ≥ 30 ms	1	Q ≥ 30 ms	1	Q ≥ 40 ms	1	Q ≥ 30 ms	1
	R/Q ≤ 1	2	R/Q ≤ 1	2	R/Q ≤ 1	2	R/Q ≤ 1	2	R/Q ≤ 1	2
	R/Q ≤ 2	1	R/Q ≤ 2	1	R/Q ≤ 2	1	R/Q ≤ 2	1	R/Q ≤ 2	1
V1 Ant.	Q ≥ 50 ms	2			Q ≥ 50 ms	2	any QR			
	any Q	1	any QR	1	any Q	1	(or any Q if *)	1	any Q	1
	Init R ≤ 20 ms						NtchInit40			
V1 Post.**			R/S ≥ 1	1		1	R/S ≥ 1	1	R/S ≥ 1	1
	Init R ≥ 60 ms	2	R ≥ 50 ms	2	Init R ≥ 60 ms	2	R ≥ 50 ms	2	R ≥ 50 ms	2
	Init R ≥ 1.5 mV		R ≥ 1mV		Init R ≥ 1.5 mV		R ≥ 1mV		R ≥ 1mV	
	Init R ≥ 50 ms	1	R ≥ 40 ms	1	Init R ≥ 50 ms	1	R ≥ 40 ms	1	R ≥ 40 ms	1
	Init R ≥ 1.0 mV		R ≥ 0.7 mV		Init R ≥ 1.0 mV		R ≥ 0.7 mV		R ≥ 0.7 mV	
			Q≤0.2&S≤0.2mV	1			Q≤0.2&S≤0.2 mV	1	Q≤0.2&S≤0.2mV	1
V2 Ant.	Q ≥ 50 ms	2			Q ≥ 50 ms	2				
	any Q	1	any QR	1	any Q	1	any QR	1	any Q	1
	R ≤ 10 ms		R ≤ 10 ms		R ≤ 10 ms		(or any Q if *)		R ≤ 10 ms	
	R ≤ 0.1mV		R ≤ 0.1mV		R ≤ 0.1mV		NtchInit40		R ≤ 0.1mV	
V2 Post.**			R/S ≥ 1.5	1			R/S ≥ 1.5	1	R/S ≥ 1.5	1
	Init R ≥ 70 ms	2	R ≥ 60 ms	2	Init R ≥ 70 ms	2	R ≥ 60 ms	2	R ≥ 60 ms	2
	Init R ≥ 2.5 mV		R ≥ 2 mV		Init R ≥ 2.5 mV		R ≥ 2 mV		R ≥ 2 mV	
	Init R ≥ 50 ms	1	R ≥ 50 ms	1	Init R ≥ 50 ms	1	R ≥ 50 ms	1	R ≥ 50 ms	1
	Init R ≥ 2.0 mV		R ≥ 1.5 mV		Init R ≥ 2.0 mV		R ≥ 1.5 mV		R ≥ 1.5 mV	
			Q≤0.3&S≤0.3mV	1			Q≤0.3&S≤0.3mV	1	Q≤0.3&S≤0.3mV	1
V3	Q ≥ 30 ms	2	Q ≥ 30 ms	2	Q ≥ 30 ms	2	QR& (Q ≥ 30 ms)	2	Q ≥ 30 ms	2
	R ≤ 10 ms		R ≤ 10 ms		R ≤ 10 ms		NtchInit40	1	R ≤ 10 ms	
	Q ≥ 20 ms	1	Q ≥ 20 ms	1	Q ≥ 20 ms	1	any QR		Q ≥ 20 ms	1
	R ≤ 20 ms		R ≤ 20 ms		R ≤ 20 ms		(or any Q if *)		R ≤ 20 ms	
V4	Q ≥ 20 ms	1	Q ≥ 20 ms	1	Q ≥ 20 ms	1	Q ≥ 20 ms	1	Q ≥ 20 ms	1
	R/Q ≤ 0.5	2	R/Q ≤ 0.5	2	R/Q ≤ 0.5	2	R/Q ≤ 0.5	2	R/Q ≤ 0.5	2
	R/S ≤ 0.5		R/S ≤ 0.5		R/S ≤ 0.5		R/S ≤ 0.5		R/S ≤ 0.5	
	R/Q ≤ 1	1	R/Q ≤ 1	1	R/Q ≤ 1	1	R/Q ≤ 1	1	R/Q ≤ 1	1
	R/S ≤ 1		R/S ≤ 1		R/S ≤ 1		R/S ≤ 1		R/S ≤ 1	
	R ≤ 0.5 mV		R ≤ 0.5 mV		R ≤ 0.5 mV		R ≤ 0.5 mV		R ≤ 0.5 mV	
	NtchInit40		NtchInit40		NtchInit40		NtchInit40		NtchInit40	
V5	Q ≥ 30 ms	1	Q ≥ 30 ms	1	Q ≥ 30 ms	1	Q ≥ 30 ms	1	Q ≥ 30 ms	1
	R/Q ≤ 1	2	R/Q ≤ 1	2	R/Q ≤ 1	2	R/Q ≤ 1	2	R/Q ≤ 1	2
	R/S ≤ 1		R/S ≤ 1		R/S ≤ 1		R/S ≤ 1		R/S ≤ 1	
	R/Q ≤ 2	1	R/Q ≤ 2	1	R/Q ≤ 2	1	R/Q ≤ 2	1	R/Q ≤ 2	1
	R/S ≤ 2		R/S ≤ 1.5		R/S ≤ 1.5		R/S ≤ 2		R/S ≤ 2	
	R ≤ 0.6 mV		R ≤ 0.6 mV		R ≤ 0.6 mV		R ≤ 0.6 mV		R ≤ 0.6 mV	
	NtchInit40		NtchInit40		NtchInit40		NtchInit40		NtchInit40	
V6	Q ≥ 30 ms	1	Q ≥ 30 ms	1	Q ≥ 30 ms	1	Q ≥ 30 ms	1	Q ≥ 30 ms	1
	R/Q ≤ 1	2	R/Q ≤ 1	2	R/Q ≤ 1	2	R/Q ≤ 1	2	R/Q ≤ 1	2
	R/S ≤ 1		R/S ≤ 1		R/S ≤ 1		R/S ≤ 1		R/S ≤ 1	
	R/Q ≤ 3	1	R/Q ≤ 3	1	R/Q ≤ 3	1	R/Q ≤ 3	1	R/Q ≤ 3	1
	R/S ≤ 3		R/S ≤ 2		R/S ≤ 2		R/S ≤ 3		R/S ≤ 3	
	R ≤ 0.6 mV		R ≤ 0.6 mV		R ≤ 0.6 mV		R ≤ 0.6 mV		R ≤ 0.6 mV	
	NtchInit40		NtchInit40		NtchInit40		NtchInit40		NtchInit40	
Total	Points		Points		Points		Points		Points	

%LV infarct (3 x #pts) ____ %LV infarct (3 x #pts) ____ %LV infarct (3 x #pts) ____ %LV infarct (3 x #pts) ____ %LV infarct (3 x #pts) ____

	LBBB	
Lead	Critera	Pts
I	any Q	1
	R/Q ≤ 1	2
	R/S ≤ 1	
	R/Q ≤ 1.5	1
	R/S ≤ 1.5	
II	Q ≥ 40 ms	2
	Q ≥ 30 ms	1
	R/Q ≤ 0.5	1
	R/S ≤ 0.5	
aVL	Q ≥ 50 ms	2
	Q ≥ 40 ms	1
	R/S ≤ 0.5	2
	R/Q ≤ 0.5	
	R/S ≤ 1	1
	R/Q ≤ 1	
aVF	Q ≥ 50 ms	2
	Q ≥ 40 ms	1
	R/Q ≤ 0.5	1
	R/S ≤ 0.5	
V1 Ant.***	Nchinit40	1
	R ≥ 0.3 mV	2
	R ≥ 30 ms	
	R ≥ 0.2 mV	1
	R ≥ 20 ms	
V1 Post	S/S' ≥ 2.0	3
	S/S' ≥ 1.5	2
	S/S' ≥ 1.25	1
V2 Ant.***	Nchinit40	1
	R ≥ 0.4 mV	2
	R ≥ 30 ms	
	R ≥ 0.3 mV	1
	R ≥ 20 ms	
V2 Post	S/S' ≥ 2.5	3
	S/S' ≥ 2.0	2
	S/S' ≥ 1.5	1
V5	any Q	1
	R/R' ≥ 2	2
	R/R' ≥ 1	1
	R/S ≤ 2	
	R ≤ 0.5 mV	1
V6	Q ≥ 20 ms	1
	R/R' ≥ 2	2
	R/R' ≥ 1	1
	R/S ≤ 2	
	R ≤ 0.6 mV	1
Total	Points	

%LV infarct (3 * #pts) ____

* (for LVH) if ≥4 other points in leads I, aVL, V4, V5 or V6 then count QS in V1-V3
** (RAO) if P positive amp in V1≥0.1mV or aVF P ≥0.175 mV, then exclude V1-V2 Post criteria
*** (RAO) if P positive amp in V1 ≥0.1mV or aVF P ≥0.175 mV, then exclude V1-V2 R-criteria points

Figure 7: The score sheet for QRS.

Table 1: The demographic data, 2D, 3D echocardiographic parameters, values are presented as mean ± SD		
Parameters	**Mean**	**Standard deviation**
Age	59.2	5.597
BMI	28.44	4
2D-EF	40%	0.09
3D-EF	36%	0.09
E/*A*	1.46	1.24
E/*e*’	13.03	7.9
Selvester score	6.1	3.51
LV infarct size	20%	0.09

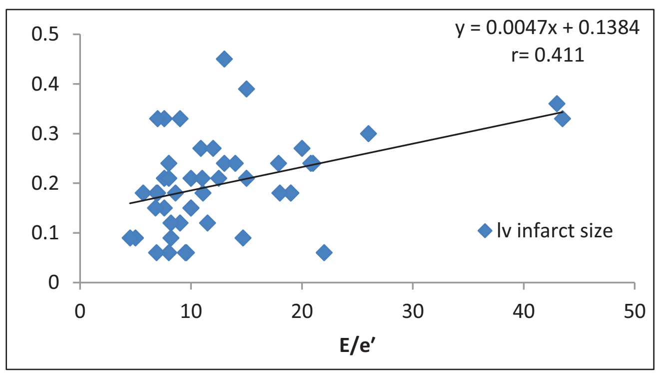


Figure 8: Correlation studies between left ventricular infarct size by Selvester score with echocardiographic derived *E*/*e*′ of mitral valve inflow

of awareness of ischemic symptoms among patients, in addition to a high incidence of risk factors, leads to a high mortality rate in patients with coronary artery disease (CAD). Further research is needed to clarify the diagnostic methods and therapeutic implications.[19-20]

Conclusion

Selvester scoring can be used in the assessment of infarct size in anterior MI patients, and could additionally reflect the degree of systolic and diastolic LV dysfunction from the significant correlation results of this study, so it could be considered a part of the routine evaluation of ECGs in these patients.

Financial support and sponsorship

Nil.

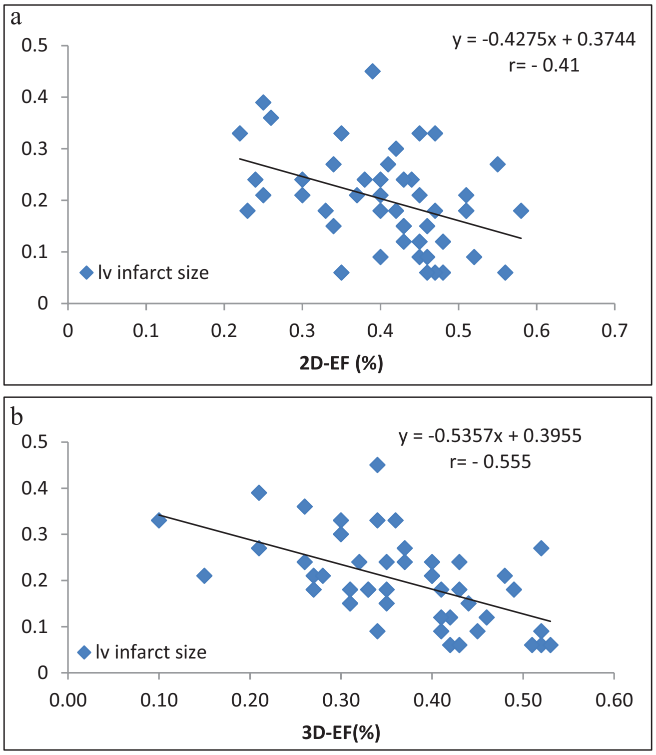


Figure 9: Correlation studies between left ventricular infarct size by Selvester score, and (a) 2D echocardiographic derives ejection fraction (EF) and (b) 3D ejection fraction

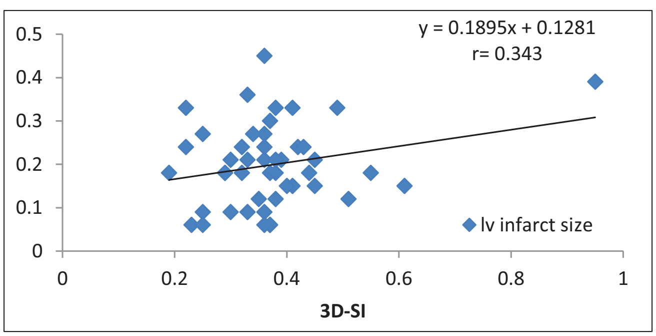


Figure 10: Correlation studies between infarct size of left ventricular by Selvester score, and 3D echocardiographic derived sphericity index

Conflicts of interest

There are no conflicts of interest.

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