Section: Cardiology

Original Research Article

COMPARATIVE EVALUATION OF WALL MOTION SCORE INDEX AND LEFT VENTRICULAR EJECTION FRACTION IN PREDICTING CARDIOVASCULAR OUTCOMES FOLLOWING ACUTE MYOCARDIAL INFARCTION

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ABSTRACT

Background: Acute myocardial infarction (AMI) is a major cause of cardiovascular morbidity and mortality, despite advances in therapy. Accurate prognostic stratification can identify high-risk patients. This study compared the WMSI and LVEF in predicting adverse cardiovascular outcomes, including mortality and heart failure readmission after myocardial infarction. **Materials and Methods:** This prospective study included 100 patients with acute myocardial infarction at a tertiary care hospital. Patients with STEMI and NSTEMI underwent echocardiography within 48 h. LVEF was calculated using Simpson's method, and WMSI was assessed using a 16-segment model. Patients were categorised according to their LVEF and WMSI. The primary outcome was a composite of all-cause mortality and heart failure readmission during the follow-up period. **Result:** The mean age of the patients was 61.2±10.1 years. The mean LVEF and WMSI were 42.1±8.2% and 1.48±0.33, respectively. Males comprised 71% of the population, and STEMI and NSTEMI accounted for 59% and 41% of the cases, respectively. LVEF <40% was in 54%, WMSI >1.5 in 57%. The mortality rate was 5%, heart failure readmission rate was 10%, and composite cardiovascular event rate was 15%. Composite events were higher in LVEF <40% than in LVEF ≥40% (20% vs. 9%; p=0.048) and in WMSI >1.5 than in WMSI ≤1.5 (25% vs. 2%; p=0.003). **Conclusion:** Both LVEF and WMSI predicted adverse post-myocardial infarction outcomes. WMSI showed a stronger association with heart failure readmission and may enhance post-infarction risk stratification when combined with LVEF assessment in patients with acute myocardial infarction.

INTRODUCTION

Acute myocardial infarction (AMI) is a major cardiovascular challenge and a leading cause of morbidity and mortality, despite advances in reperfusion and therapy. AMI survivors face risks such as heart failure, ventricular dysfunction, recurrent ischaemia, and death.[1,2] Heart failure increases post-infarction mortality. Ventricular remodelling and dysfunction contribute to disease progression, highlighting the need for early prognostic assessment.[3,4] The pathophysiology of AMI involves ischaemic necrosis and inflammatory processes that affect infarct expansion and dysfunction. Inflammatory mediators influence the severity and outcomes of the disease.[1] Mechanical complications may worsen cardiac function despite reperfusion.[2] Early identification of high-risk patients is crucial for optimising interventions. Assessing left ventricular systolic function is central to the risk stratification.

Echocardiography is preferred because of its accessibility, safety, and utility. Left ventricular ejection fraction (LVEF) evaluates systolic performance and post-infarction risk.[5] LVEF identifies patients at risk of heart failure and death.6 Reduced LVEF is linked to adverse outcomes and guides post-AMI therapy. However, LVEF has limitations, showing global performance and possibly inadequately characterising regional dysfunction, particularly with segmental abnormalities.[7] It relies on geometric assumptions, which reduces the accuracy in asymmetrically remodelled ventricles. LVEF is influenced by preload and afterload conditions and fluctuates during myocardial infarction phases, limiting its reliability as a contractility indicator.[8] Additionally, LVEF does not directly assess myocardial deformation or regional mechanics, potentially missing subtle dysfunctions before global impairment.[8]

Interest in alternative echocardiographic parameters for assessing myocardial injury post-AMI has grown due to these limitations. The Wall Motion Score Index (WMSI), derived from a segmental analysis of myocardial contractility, evaluates ventricular dysfunction and detects localised damage overlooked by global systolic measurements.[9,10] The WMSI scores myocardial segments, estimating infarct size and injury distribution, as wall motion abnormalities correlate with ischaemic damage.[10] Elevated WMSI has been linked to adverse remodelling, impaired perfusion, and increased infarct transmurality.[11] The WMSI identifies dysfunction in patients with preserved or mildly reduced LVEF, offering additional prognostic value. WMSI correlates with adverse cardiovascular outcomes, including mortality and heart failure-related hospitalisation post-AMI. In patients undergoing primary PCI for ST-segment elevation myocardial infarction, WMSI showed superior predictive ability for mortality and cardiovascular endpoints compared with LVEF in some settings.[12,13]

Advanced imaging modalities have validated WMSI's relationship between WMSI and infarct severity, reinforcing its clinical relevance.[9] Despite the significance of LVEF and WMSI, evidence of their relative predictive performance is inconsistent. Some studies have shown that WMSI offers superior prognostic discrimination, especially in patients with preserved LVEF or regional dysfunction, while others have found comparable performance after adjustment.[12] Many studies have been conducted in selected populations, limiting their generalisability to broader clinical practice.[14] Uncertainty remains regarding the optimal echocardiographic parameter for prognostic stratification after AMI in the general population. Further evaluation of WMSI and LVEF is required to determine their utility in predicting adverse outcomes after myocardial infarction. Clarifying their prognostic value may improve the identification of high-risk patients and facilitate individualised therapies.

Aim: This study compared the prognostic utility of the Wall Motion Score Index (WMSI) and Left Ventricular Ejection Fraction (LVEF) in predicting adverse cardiovascular outcomes, including mortality and heart failure readmission, post-acute myocardial infarction.

MATERIALS AND METHODS

This prospective observational study included 100 patients from the Department of Cardiology at a tertiary care hospital in India. Ethical approval and written informed consent were obtained from the participants before the initiation of the study.

Inclusion and Exclusion criteria

This study included adults aged ≥18 years who were admitted with acute myocardial infarction within 48 h of symptom onset. Diagnosis was based on ischaemic chest pain, electrocardiographic changes, and elevated cardiac biomarkers. Patients with STEMI and NSTEMI were included. Patients with mechanical complications, such as ventricular septal rupture, papillary muscle rupture, free wall rupture, cardiogenic shock, prior significant valvular heart disease, congenital heart disease, previous cardiomyopathy, poor echocardiographic window, or cardiac arrest, were excluded.

Materials

The study materials included a commercial echocardiography ultrasound system, electrocardiographic monitoring equipment, cardiac biomarker assays, antiplatelet drugs, statins, beta-blockers, angiotensin-converting enzyme receptor blockers, thrombolytic agents, and materials for coronary angiography and percutaneous coronary intervention.

Methods

One hundred patients were evaluated for Left Ventricular Ejection Fraction (LVEF) and Wall Motion Score Index (WMSI). Patients were categorized into LVEF <40% and LVEF ≥40% groups and WMSI >1.5 and WMSI ≤1.5 groups. The WMSI cutoff of >1.5 was selected based on previous studies demonstrating increased adverse cardiovascular risk with elevated regional wall motion abnormalities.[12,13] All patients received guideline-directed medical therapy unless contraindicated. STEMI patients underwent reperfusion therapy via primary percutaneous coronary intervention or thrombolysis with a pharmaco-invasive approach where appropriate. NSTEMI patients had an early invasive strategy including coronary angiography and revascularization based on coronary anatomy and clinical indication. Transthoracic echocardiography was performed after hemodynamic stabilization within 48 hours of admission using a standardized protocol.

LVEF was calculated using the biplane Simpson's method from apical two- and four-chamber views and expressed as a percentage. WMSI was assessed using the standard 16-segment model. Myocardial segments were scored as normal or hyperkinetic (1 point), hypokinetic (2 points), akinetic (3 points), and dyskinetic (4 points). WMSI was calculated by dividing the total score by the number of segments.

The primary outcome was a composite cardiovascular outcome including all-cause mortality and heart failure-related readmissions during follow-up. The secondary outcomes included individual assessments of mortality and rehospitalisation due to heart failure. Follow-up assessments were conducted through outpatient visits and telephone interviews at regular intervals after discharge.

Statistical analysis: Data are presented as mean, standard deviation, frequency, and percentage.

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Variables were compared using the independent Student's t-test for continuous data and the Chi-square or Fisher's exact test for categorical data. Statistical significance was set at P<0.05, and analyses were performed using IBM-SPSS version 21.0 (IBM-SPSS Science Inc., Chicago, IL, USA).

RESULTS

The mean age of the patients was 61.2±10.1 years. The mean LVEF was 42.1±8.2%, and the mean WMSI was 1.48±0.33 [Table 1].

Among the patients, 71% were men and 29% were women. 59% had STEMI and 41% had NSTEMI. Regarding left ventricular function, 54% had LVEF <40%, and 46% had LVEF ≥40%. In regional wall motion, 57% showed WMSI >1.5, and 43% had WMSI ≤1.5. Cardiovascular outcomes included heart failure readmission in 10% of patients, mortality in 5%, and composite events in 15% of patients [Table 2].

Table 1: Baseline Echocardiographic and Demographic Characteristics

	Mean ± SD
Age (years)	61.2 ± 10.1
LVEF (%)	42.1 ± 8.2
WMSI	1.48 ± 0.33

Table 2: Clinical Characteristics and Cardiovascular Outcomes of the Patients

		N (%)
Sex	Male	71 (71%)
	Female	29 (29%)
Types of MI	STEMI	59 (59%)
	NSTEMI	41 (41%)
LVEF	< 40%	54 (54%)
	≥ 40%	46 (46%)
WMSI	> 1.5	57 (57%)
	≤ 1.5	43 (43%)
Outcomes	Mortality	5 (5%)
	HF Readmission	10 (10%)
	Composite Events	15 (15%)

Composite cardiovascular events were more frequent in patients with LVEF <40% than in those with LVEF ≥40% (20% vs. 9%), a significant difference (p=0.048). Similarly, patients with WMSI >1.5 showed a higher incidence compared to WMSI ≤1.5 (25% vs. 2%, respectively), which was also significant (p=0.003) [Table 3].

Table 3: Comparison of Composite Cardiovascular Events Based on LVEF and WMSI

		N (%)	**P value**
		Composite Events	
LVEF	< 40%	11 (20%)	0.048
	≥ 40%	4 (9%)	
WMSI	> 1.5	14 (25%)	0.003
	≤ 1.5	1 (2%)	

Patients who died had a lower mean LVEF than those who survived (36.5±6.5% vs. 41.9±9.1%; p=0.041). The mean WMSI was higher in patients who died than in those who survived (1.72±0.27 vs. 1.46±0.33; p=0.018) [Table 4].

Table 4: Comparison of LVEF and WMSI Based on Mortality

	Mean ± SD		**P value**
	Mortality Present	**Mortality Absent**	
LVEF (%)	36.5 ± 6.5	41.9 ± 9.1	0.041
WMSI	1.72 ± 0.27	1.46 ± 0.33	0.018

Patients with heart failure readmission had a lower mean LVEF than those without (35.1±6.8% vs. 40.0±9.2%), but this was not significant (p=0.072). In comparison, the mean WMSI was significantly higher in the readmitted patients (1.66±0.30 vs. 1.45±0.33; p=0.015) [Table 5].

Table 5: Comparison of LVEF and WMSI Based on Heart Failure Readmission

	Mean ± SD		**P value**
	HF Readmission	**No HF Readmission**	
LVEF (%)	35.1 ± 6.8	40.0 ± 9.2	0.072
WMSI	1.66 ± 0.30	1.45 ± 0.33	0.015

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DISCUSSION

Our study compared the prognostic utility of the Wall Motion Score Index (WMSI) and Left Ventricular Ejection Fraction (LVEF) for predicting adverse cardiovascular outcomes after acute myocardial infarction (AMI). Both LVEF and WMSI were associated with adverse outcomes, but WMSI showed stronger association with adverse outcomes for cardiovascular events and heart failure readmission. Elevated WMSI was associated with higher mortality and heart failure-related rehospitalisation, indicating that regional ventricular dysfunction offers additional prognostic information beyond global systolic assessment. The mean age was 61.2±10.1 years, with 71% males, similar to previous AMI populations. This demographic similarity shows that ventricular dysfunction assessment by echocardiography remains relevant in AMI populations.

In our study, STEMI accounted for 59% of the cases, and NSTEMI accounted for 41%. The mean LVEF was 42.1±8.2%, with 54% having LVEF <40%. The mean WMSI was 1.48±0.33, with 57% of patients having WMSI >1.5. Jurado-Román et al. reported mean LVEF and WMSI values of 52.2±11.4% and 1.46±0.4, respectively, with patients experiencing adverse events having lower LVEF (41.5±11.5% vs. 54.1±10.4%; p<0.0001) and higher WMSI (1.83±0.3 vs. 1.39±0.3; p<0.0001).[13] Our study similarly found that patients with mortality had lower LVEF (36.5±6.5% vs. 41.9±9.1%; p=0.041) and higher WMSI (1.72±0.27 vs. 1.46±0.33; p=0.018).

Our study showed that composite cardiovascular events occurred in 15% of patients. Patients with LVEF <40% had higher event rates than those with LVEF ≥40% (20% vs. 9%; p=0.048). Prognostic separation was stronger with WMSI; patients with WMSI >1.5 had higher event rates than those with WMSI ≤1.5 (25% vs. 2%; p=0.003). These findings show that regional ventricular dysfunction may better reflect infarct extent and myocardial injury than global systolic assessment alone. Jurado-Román et al. found that both WMSI and LVEF predicted mortality and heart failure readmission, with WMSI >1.8 being the strongest predictor (hazard ratio 8.5; 95% CI: 3.7–18.8; p<0.0001).[13]

Jurado-Román et al. also reported that 80.7% of patients had elevated WMSI despite preserved LVEF >40%, highlighting the ability of WMSI to identify regional dysfunction not detected by global ejection fraction.[13] This may explain WMSI's better differentiation of adverse outcomes of WMSI in our study, especially for heart failure outcomes. Savage et al. supported WMSI's prognostic superiority of WMSI in 1181 STEMI patients treated with primary PCI, where WMSI ≥1.8 was linked to poorer 12-month survival (9.2% vs. 1.5%; p<0.001). WMSI showed better discriminatory ability for 12-month mortality than LVEF, with an AUC of 0.77 vs. 0.71 (p=0.034).[12] These findings align with those of our study, in which WMSI had a stronger association with adverse outcomes than LVEF.

In our study, mortality occurred in 5% of patients, and heart failure readmission occurred in 10%. WMSI had a stronger relationship with heart failure readmission than LVEF did. Patients who were readmitted with heart failure had higher WMSI values (1.66±0.30 vs. 1.45±0.33; p=0.015), whereas LVEF reduction was not significant (35.1±6.8% vs. 40.0±9.2%; p=0.072). These findings are similar to those of a study by Venkateshwaran and Arumugan, who reported 3.7% mortality and 11% heart failure readmission after one year, concluding that WMSI was a superior predictor of rehospitalisation due to heart failure.[16] Pandit et al. demonstrated the elevated clinical relevance of WMSI in predicting early adverse outcomes after AMI, with 22.58% mortality in patients with WMSI ≥2 vs. 2.90% in those with WMSI <2 (p<0.05). A higher WMSI was associated with an increased Killip class, arrhythmias, and adverse in-hospital outcomes.[15] These findings support our study, which showed that worsening regional wall motion abnormalities are associated with more extensive myocardial damage and a worse prognosis.

Bae et al. analysed 3,510 AMI patients from the KAMIR-NIH registry and found that patients with improved LVEF and WMSI post-PCI had significantly lower rates of major adverse cardiovascular events than those with deterioration (7.8% vs. 17.1%; p<0.001). They also reported a significant negative correlation between LVEF and WMSI (Pearson's correlation coefficient = −0.73; p<0.001), highlighting the inverse relationship between global and regional ventricular dysfunction.[17] These findings show that serial WMSI and LVEF assessments may enhance the long-term prognostic stratification after AMI.

WMSI may provide better prognostic assessment because of physiological differences in systolic evaluation. LVEF measures overall ventricular performance and may remain preserved owing to compensatory hyperkinesia of non-infarcted segments. In contrast, WMSI evaluates segmental myocardial contractility, accurately showing infarct size and dysfunction. Jurado-Román et al. emphasised that WMSI avoids the compensatory effect of hypercontractile segments, which may falsely preserve the global ejection fraction, contributing to WMSI's stronger prognostic performance of WMSI.[13]

CONCLUSION

Both LVEF and WMSI were associated with adverse cardiovascular outcomes after acute myocardial infarction. Patients with reduced LVEF and elevated WMSI had higher rates of cardiovascular events and mortality. Although patients with heart failure readmission had lower mean LVEF values, the association was not significant. Elevated WMSI was significantly associated with heart failure rehospitalisation, suggesting a stronger association with adverse outcomes. Our study showed that WMSI may provide additional prognostic information beyond LVEF by reflecting regional myocardial dysfunction and the extent of injury. Segmental assessment using WMSI may help identify high-risk patients, especially those with preserved or mildly reduced systolic function. Combining WMSI with LVEF may enhance early risk stratification and help identify patients who may benefit from closer monitoring and aggressive therapy.

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