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Original Article

Sensitivity and Specificity of Myocardial Performance Indexing Assessing Acute Right Ventricular Infarction

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Abstract:

The goal of this study was to determine the sensitivity and specificity of the Myocardial Performance Index (MPI)for the assessment of acute right ventricular Infraction. This was a descriptive type of cross-sectional study. The study was carried out in the Coronary Care Unit, Department of Cardiology, Sir Salimulla Medical College, and Mitford Hospital. After exclusion total of 72 patients were included in this study, of which 24 had acute inferior MI with RV involvement diagnosed by ≥ 1mm ST-segment elevation in V3R-V5R of right-sided ECG (group-I) and 48 had acute inferior MI without RV involvement (group-II). All patients underwent echocardiography within 24 hours of admission.

The study revealed that RV MPI was significantly increased (0.57± 0.13) in RVMI patients compared to IMI without RVMI (0.24± 0.12). MPI detected RVMI in 08 patients (0.45± 0.09) who did not have ECG findings of RVMI (Group-II). Repeat MPI estimation after 05 days in 21 RVMI (Group-I) and 08 isolated IMI (Group-II) patients who had RVMPI > 0.30showed dramatic reduction of MPI (0.19± 0.07 and 0.22±0.09), respectively. RV MPI ≥ 0.30 has high sensitivity (100%) and specificity (89%) for the diagnosis of RVMI in the presence of acute IMI.

The study recommended that MPI may be a new non-invasive echocardiographic gold standard tool in diagnosing acute RVMI and also assessment of right ventricular function in acute inferior myocardial infarction with high sensitivity and specificity. MPI changes can be serially followed in acute RVMI patients to assess changes in RV function.

Keywords: Myocardial Performance Index, Sensitivity and Specificity, Inferior Myocardial Infarction

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Introduction

Coronary artery disease (CAD) is the leading cause of morbidity and mortality in Western society and is a worldwide epidemic. In 2001, it was estimated that ischemic heart disease (IHD) was responsible for 11.8 percent of all deaths in developing countries and 17.3 percent of all

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deaths in developed countries.[1]Incidence of IHD is increasing in developing countries, including Bangladesh, with the improvement of socioeconomic status, urbanization, and changes in dietary habits and lifestyle.[2]

Right ventricular myocardial infarction occurs in approximately one-third of patients with acute inferior wall myocardial infarction (IWMI), and hemodynamic abnormalities became clinically significant in 10% of these patients.[3]Patients with right ventricular infarctions have much higher rates of significant hypotension, bradycardia requiring pacing support, and in-hospital mortality than isolated IWMI.[4]

Assessment and quantification of right ventricular function often are difficult and challenging.[5] Diagnosis of right ventricular myocardial infarction (RVMI) is based on electrocardiographic (ECG) ST-segment elevation in lead V_4R in the inferior myocardial infarction setting. The Echocardiographic diagnosis of RVMI is straightforward if right ventricular (RV) dilation and regional wall motion abnormality are present. These changes are not evident in many RVMI patients. Also, the assessment of RV volume and function is cumbersome due to the complex geometry and inaccessible location of the RV.[6]

MPI can be defined as the Doppler-derived sum of isovolumetric contraction and relaxation periods divided by ejection time. MPI reflects combined RV systolic and diastolic function when applied to the right heart. In the setting of acute RVMI, the energy-dependent processes of RV contraction, ejection, and relaxation are likely to be altered. As MPI combines all these important time intervals, it may be a sensitive tool to diagnose "occult" RV ischemia/infarction, which may not manifest clinically and in routine 2D Echo imaging.[7]The MPI value of 0.30 appears to be an ideal cutoff value with a sensitivity of 82% and specificity of 95% for the diagnosis of RVMI in the presence of IMI.[6] The aim of the present study is to determine the sensitivity and specificity of MPI in diagnosing acute RVMI. Measurement of MPI is non-invasive, less expensive, and easily available.

Materials and Methods

This was a descriptive type of cross-sectional study. The study was carried out in the Coronary Care Unit, Department of Cardiology, Sir Salimulla Medical College, and Mitford Hospital. The study period was from Jun 201 to May 2011. A total of 72 patients of both sex diagnosed to have acute Inferior wall myocardial infarction (IWMI) were included in this study.

Inclusion criteria:

1. Patients with acute inferior myocardial infarction with or without right ventricular infarction are diagnosed by clinical features and conventional 12 lead ECG.
2. Raised level of cardiac enzymes suggestive of AMI

Exclusion criteria:

1. Patients with chest pain for more than 12h.
2. Patients with prior myocardial infarction, chronic obstructive pulmonary disease, high-grade AV block, atrial fibrillation, congenital heart disease, valvular heart disease, and post-CABG.

All suspected AMI patients admitted to CCU were enrolled for the application of inclusion and exclusion criteria. Patients with right ventricular dysfunction other than AMI were excluded clinically. Conventional 12 leads ECG were done for diagnosis of acute inferior MI. Right-sided ECG was obtained routinely in all inferior MI patients at the time of initial evaluation. On ECG, right ventricular infarction was defined as ≥1 mm elevation of ST-segment in leads V3R–V5R.[5]Clinical data, including clinical history and treatment history, was recorded. Clinical features, relevant physical examination, and baseline laboratory investigations like random blood sugar, serum creatinine, lipid profile, and troponin-I were done.

Patients were divided into two groups based on the presence or absence of RVMI on right-sided ECG -

- Group- I: Patients with acute inferior MI with RVMI.

- Group- II: Patients with acute inferior MI without RVMI.

Echocardiography, including MPI was done in all patients within 24 hours of admission. All the echocardiograms were reported by an experienced physician using VIVID 7. The reporting physician was blinded to the clinical diagnosis.

Right ventricular myocardial performance index (MPI) is calculated as follows. First, the tricuspid inflow is interrogated by pulse wave Doppler (PWD) in the apical four-chamber view, and the time interval from the end of the "A" wave to the onset of the next "E" wave is noted as "a" in milliseconds. Then the right ventricular outflow is interrogated by PWD in the parasternal short-axis view. The total pulmonary ejection time is indicated as "b." Three consecutive cardiac cycles are averaged to obtain each value for "a" and "b" to correct for heart rate variation and measurement errors. The time interval "a" denotes combination of isovolumetric contraction time (IVCT), ejection time (ET), and isovolumetric relaxation time (IVRT). As the Doppler period “b” is the pulmonary ET, the sum of IVCT and IVRT is derived by subtracting “b” from “a.” MPI is calculated as MPI = (a − b)/b, and a dimensionless ratio is obtained.

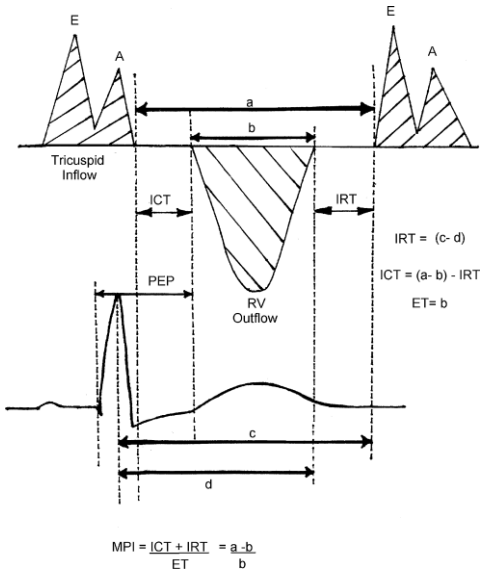

Figure 1: Illustration of measurements for a myocardial performance index.

Follow-up was done during a hospital stay. During the study, complications and mode of outcome were recorded. In addition, echocardiography, including MPI was done in all RVMI patients after05days of admission.

Results

A total of 72 patients were enrolled in this study. Among the study population, 24 were Group-I (Patients with acute inferior MI with RVMI) and 48 were Group-II (Patients with acute inferior MI without RVMI). The mean age in Group I was 52.25 ± 10.90 (SD), and in Group II was 49.13 ± 10.56 (SD). Among the study subjects, 60 (83.3%) were male, and 12 (16.7%) were females. The male: female ratio was 5:1. Comparing risk factors among Group I and Group II study subjects, it was found that diabetes mellitus was more common in Group I (54.2% in Group I and 35.4%) in group II) Family history of IHD was more common in group II (16.7% in Group I and 54.2% in Group II). The distribution of hypertension and smoking were almost the same between the two groups 41.7% and 75% vs. 41.7 and 77.1%) of patients, respectively (Table-I).

Table- I: Comparison of risk factors in Group I and Group II study subjects

Risk Factors	**Group-I** (IMI + RVMI) No (%)	**Group-II** (IMI) No (%)	**p-value**
Hypertension	10 (41.70%)	20 (41.70%)	Not significant
Diabetes mellitus	13 (54.20%)	17 (35.40%)	Not significant
Smoking	18 (75%)	37 (77.10%)	Not significant
Dyslipidemia	2 (8.30%)	1 (2.10%)	Not significant
Family history of IHD	4 (16.70%)	26 (54.20%)	<.05

p-value reached from chi-square test, d.f. =

All patients underwent echocardiography, including MPI, within 24 hours of admission. RV MPI in Group I patients was significantly increased (0.57±0.13) compared to group II patients (0.24±0.12).

Table 2: Echo parameters

Echo parameters	**Group-I** (IMI + RVMI) n=24	**Group-II** (IMI) n=48	**X^2 value / p-value**
RVWMAS	1.35 ± 0.35	1.08 ± 0.19	<.05
ICT+IRT+ET	382.81 ± 32.52	331.56 ± 42.49	Not significant
ET	244.34 ± 23.20	267.75 ± 29.27	Not significant
ICT+IRT	138.43 ± 27.28	63.84 ± 31.06	Not significant
RVMPI	0.57 ± 0.13	0.24 ± 0.12	<.05
LVEF	46 ± 5.12	46.5 ± 5.36	Not significant

p value reached from chi-square test, d.f. = 3

ICT : Isovolumetric contraction time

IRT : Isovolumetric` relaxation time

ET : Ejection time

RVMPI : Right ventricular myocardial performance index

LVEF : Left ventricular ejection fraction

A comparison between MPI and right-sided ECGshows 24(100%) patients of Group I had MPI of more than 0.30. Among Group II, 40(83.3%) had MPI <0.30 but 8 (16.7%) patients had MPI >0.30

Table: 3. Performance of diagnostic test by calculating sensitivity, specificity, accuracy, and positive and negative predictive values of RVMPI in diagnosing RVMI

		Right-sided ECG		
		Group-I (IMI + RVMI) Positive	**Group-II** (IMI) Negative	
MPI	RVMPI { >.30 } Positive	**True Positive** (TP) = 24	**False Positive** (FP) = 8	**Positive predictive value** = TP / (TP + FP) = 24 / (24 + 8) = **75%**
	RVMPI { <.30 } Negative	**False Negative** (FN) = 0	**True Negative** (TN) = 40	**Negative predictive value** = TN / (FN + TN) = 40 / (0 + 40) = **100%**
		Sensitivity = TP / (TP + FN) = 24 / (24 + 0) = **100%**	**Specificity** = TN / (FP + TN) = 40 / (8 + 40) = **83.33%**	

Accuracy= (True Positive + True Negative) / N (True Positive + True Negative+ False Positive + False Negative) = (24+40)/72 = 88.89%

RVMI follow-up echocardiography shows the dramatic reduction of MPI toward normal by five days after RVMI. Also, this quick "recovery" of MPI toward normal confirms good tracking of RV function by MPI.RV MPI $\geq$ 0.30 has high sensitivity (100%) and specificity (88.89%) for the diagnosis of RVMI in the presence of acute inferior MI.

Table- 4: Follow-up echo parameters of group-I (IMI+RVMI) patients

n=21

Echo parameters	**Initial echocardiography**	**Follow-up echo**	**Difference**	**p-value**
ICT+IRT+ET	383.87 ± 34.28	333.96 ± 23.35	- 49.92 ± 44.45	<.05
ET	244.17 ± 24.46	280.84 ± 18.71	36.67 ± 26.37	<.05
ICT+IRT	139.66 ± 27.78	53.23 ± 19.93	- 86.43 ± 30.17	<.05
RVMPI	0.57 ± 0.13	0.19 ± 0.07	- 0.38 ± 0.12	<.05
LVEF	45.76 ± 5.49	55.62 ± 5.14	9.68 ± 4.13	<.05

p value reached from paired t test, d.f. = 20
ICT : Isovolumetric contraction time
IRT : Isovolumetric` relaxation time
ET : Ejection time
RVMPI : Right ventricular myocardial performance index
LVEF : Left ventricular ejection fraction

Table 5: Follow-up echo parameters of group-II (IMI) patients who had RVMPI ≥ 0.30 n=8

Echo parameters	Initial echocardiography	Follow-up echo	Difference	p-value
ICT+IRT+ET	379.03 ± 31.96	337.47 ± 25.31	- 41.56 ± 26.37	<.05
ET	261 ± 18.14	276.97 ± 15.04	15.97 ± 13.57	<.05
ICT+IRT	117.53 ± 23.44	60.50 ± 23.22	- 57.04 ± 23.04	<.05
RVMPI	0.45 ± 0.09	0.22 ± 0.09	- 0.23 ± 0.9	<.05
LVEF	45.75 ± 1.83	55.75 ± 6.47	10 ± 6.55	<.05

p value reached from paired t test, d.f. = 7

ICT : Isovolumetric contraction time

IRT : Isovolumetric` relaxation time

ET : Ejection time

RVMPI : Right ventricular myocardial performance index

LVEF : Left ventricular ejection fraction

Discussion

The prevalence of right ventricular infarction in acute inferior myocardial infarction in this study was 33.33% which is consistent with that found in Andersen's study[8] as they showed the range of frequency of RVMI in patients with inferior MI was 10-50%.

The ECG is a valuable, non-invasive, easily repeatable, and inexpensive means of diagnosing right ventricular infarction. ST-segment elevation in lead V4R has an overall sensitivity of 88%, specificity of 78%, and diagnostic accuracy of 83%.[9.]

The clinical triad of hypotension, clear lung fields, and elevated JVP in a patient with an inferior MI is virtually pathognomonic of right ventricular infarction.[10]This clinical triad was also found in the majority of our patients.

In the current study, the mean age in Group I was 52.25 ± 10.90 years, and in Group II was 49.13 ± 10.56 years. Among the study subjects, 60 (83.3%) were male, and 12 (16.7%) were females. The male: female ratio was 5:1.

In Khan's study[9], while comparing group-I (RVMI) and group-II (IMI), it was found that smoking and diabetes mellitus were more common in group-I, while hypertension and family history of IHD were more common in Group II. In this current study, diabetes mellitus was more common in Group I(54.2% in Group I and 35.4% in Group II). The distribution of hypertension and smoking were almost the same between the two groups, 41.7% and 75% vs. 41.7% and 77.1% of patients, respectively. Family history of IHD was more common in group II (16.7% in Group I and 54.2% in Group II).

In Zehender's study[11], the in-hospital complication in group-I vs. group-II was 64% and 28%, respectively, while in this study, it was 54.17% and 25%, respectively.

In Chockalingam's study[6], RVMI does not result in RV dilation and RWMA in a significant number of cases, and the mean RV MPI of RVMI patients

was 0.53± 0.22. In contrast, in this study, the MPI in Group I patients was significantly increased (0.57±0.13) compared to group II patients (0.24±0.12) and did not find RV dilation in the majority of RVMI patients.

The MPI value of 0.30 appears to be an ideal cutoff value with a sensitivity of 82% and specificity of 95% for the diagnosis of RVMI in the presence of IMI.[6]

In this study comparison between MPI and right-sided ECG was done and showed that 24(100%) patients of Group I had MPI of more than 0.30. Among Group II, 40 (83.3%) had MPI <0.30, but 8 (16.7%) patients had MPI >0.30. However, in this study, sensitivity, specificity, accuracy, PPV, and NPV for MPI were 100%, 88.33%, 88.89%, 75%, and 100%, respectively. So, Myocardial Performance Index (MPI) is a good non-invasive tool for assessing right ventricular infarction, and significant elevation in RVMI (mean = 0.57) suggests MPI is a reliable test of RV function.

In this current study, follow-up echocardiography was done in all patients of group-I and group-II (IMI) who had RVMPI ≥ 30 and showed a dramatic reduction of MPI toward normal by five days after RVMI. This quick "recovery" of MPI toward normal confirms good tracking of RV function by MPI.

Limitations of the study:

Although the result of this study is statistically significant, there were some limitations of this study.

I. The study was performed on relatively small sample size.
II. It was a single-center study
III. The invasive hemodynamic assessment was not done

Conclusion

In the current study, Right ventricular infarction was found in approximately one-third of inferior MI. Diagnosis of this condition required a high degree of suspicion based on clinical findings and an early recording of ECG through right-sided precordial leads. Right ventricular infarction was associated with considerable morbidity and mortality, and its presence defines a high-risk subgroup of patients with inferior myocardial infarction. Significant RV dilation and wall motion abnormality do not occur in over half of RVMI patients limiting the role of routine 2D echocardiography. MPI is a Doppler echo time interval, which can quickly and reliably estimate combined systolic and diastolic RV dysfunction. The narrow range of normal RV MPI increases the diagnostic power of this parameter in the setting of RVMI. The prognostic significance of RV MPI needs to be evaluated in larger series with long-term follow-up. MPI may be a new non-invasive echocardiographic gold standard tool in diagnosing RVMI and also assessment of right ventricular function in acute inferior myocardial infarction with high sensitivity and specificity. MPI changes can be serially followed in acute RVMI patients to assess changes in RV function.

Conflict of interest: None declared

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