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Echocardiographic Assessment of Right Ventricular Function by Tissue Doppler and Myocardial Perfusion in Inferior Wall Myocardial Infraction and Its Correlation with Proximal Right Coronary Artery Stenosis

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Abstract

Introduction: Right ventricular (RV) function has not been widely studied after a myocardial infarction (MI) unlike LV function. There is RV (Right Ventricular) involvement in more than 1/3rd of patients with acute IWMI. RV involvement has been reported to be an independent predictor of major complications and in-hospital mortality after acute inferior MI. Tissue Doppler indices like MPI (Myocardial Perfusion Index) have proven role in assessing global RV function. Our study is an attempt to assess various parameters of RV function within 24 h of presentation in first episode of acute inferior wall MI and to correlate them with a proximal RCA lesion in coronary angiogram.

Materials and Methods: 50 patients with acute inferior wall MI and Right ventricular infraction (RVMI) with presenting with in first 24 hours of symptom onset who underwent either primary PCI or elective PCI within one month. All patients underwent transthoracic echocardiography to assess RV function Tissue Doppler Imaging (TDI) and myocardial perfusion imaging (MPI) and coronary angiography. TDI and MPI values are very much abnormal in patients with RVMI and Proximal RCA (Right coronary artery) involvement when compared to those without RVMI or any Proximal RCA involvement.

Conclusion: The present study showed that TDI and MPI values of patients presenting with RVMI and proximal RCA stenosis are far moreless compared to those without RVMI.

Keywords: (RVMI) Right ventricular infraction, (TDI) Tissue Doppler Imaging, (MPI) Myocardial perfusion imaging.

Introduction

Right ventricular (RV) function has not been widely studied after a myocardial infarction (MI) unlike LV function [1]. There is RV involvement in more than 1/3rd of patients with acute IWMI. RV involvement has been reported to be an independent predictor of major complications and in-hospital mortality after acute inferior MI. ST-segment elevation in the right precordial lead, V_4R, is one of the most reliable electrocardiographic signs of acute RV infarction. Presence of RVMI imposes an increased risk of shock, arrhythmia and death in inferior wall MI. Occlusion of proximal dominant right coronary artery is usually responsible for RV infarction in inferior wall MI (relative risk 3.0). ECG often proves inadequate to predict proximal RCA as infarct related artery. There are only limited studies validating usefulness of various echocardiographic (Echo) parameters of RV function in assessing RV infarction and predicting proximal RCA stenosis. Most of them assessed only a single parameter of RV function and many lacked angiographic correlations. Right ventricular (RV) function has not been widely studied after a myocardial infarction (MI) unlike LV function. RV involvement has been reported to be an independent predictor of major complications and in-hospital mortality after acute inferior MI. In this study, we tried to assess whether echocardiographic assessment of RV function by Tissue Doppler and Myocardial Perfusion Index was useful to predict proximal RCA stenosis and hence identify a subset of inferior wall MI patients at higher risk of adverse clinical events.

Echocardiogram

It is one of the most important noninvasive techniques for cardiovascular diagnosis that gives reliable information together with patient safety. RV dimensions and % Fractional Shortening (FS) of different axis of the RV cavity were assessed from the apical four-chamber view according to the method proposed by Bommer et al [2] The % Fractional shortening (FS) for each axis was calculated according to the following formula:

$$\% FS = \frac{RV\ EDA - RV\ ESA}{RV\ EDA} \times 100$$

RV fractional area change measured in the apical 4-chamber view is a simple method for assessment of RV function that has correlated with RV EF (Ejection Fraction) measured by MRI and has been related to outcome in a number of disease states. RV wall motion. To assess regional wall motion of the RV was divided into four segments; diaphragmatic, free lateral, apical and interventricular septum. RV regional wall motion analysis (qualitative) was characterized as normal (>40% thickening with systole); hypokinetic (10-30% thickening), akinetic (<10% thickening), dyskinetic (paradoxical expansion in systole) or aneurysmal dilation of RV. Indices of tricuspid annular motion including TAPSE, DTI, and MPI are useful for the assessment of RV function.

1. Tricuspid Annular Peak Systolic Excursion:

Qualitative assessment of RV systolic function can be made by estimating the displacement of the tricuspid annulus. Tricuspid annular motion refers to the distance, that tricuspid annulus moves in the antero-posterior direction. In systole, the tricuspid annulus will normally descend toward the apex 1.5 to 2.0 cm. Tricuspid annular excursion of less than 1.5 cm has been associated with poor prognosis in a variety of cardiovascular diseases. Since the tricuspid valve moves toward the RV apex during ventricular systole as lengthwise shortening of both the interventricular septum and RV free wall, it is intuitively evident that TAPSE or TAPSE per time must be related to RV EF [3].The level of excursion of the tricuspid valvular plane during systole (TAPSE, in mm) corresponds with RV ejection fraction (5 mm 20% RV ejection fraction, 10 mm 30% RV ejection fraction, 15 mm 40% RV ejection fraction, and 20 mm 50% RV ejection fraction) [4,5] Tricuspid annular fractional shortening Tricuspid fractional shortening is an assessment of the difference between the maximal and minimal distance between both the tricuspid annulus during the cardiac cycle. Trans tricuspid inflow velocities because the effective orifice area of the tricuspid valve is substantially greater than that of the mitral valve, the inflow velocities are lower than the mitral valve. As for the mitral valve, however, the normal pattern consists of relatively higher early inflow (E-wave) and a lower velocity flow concordant with atrial systole (A-wave). Evaluation of right ventricular diastolic function is conventionally based on the Doppler trans tricuspid flow velocity profile. Variables measured include peak velocity of early filling (E velocity), peak velocity of late filling due to atrial

contraction (A velocity), E/A ratio and deceleration time of early filling (EDT).

2. Myocardial Performance Index – Tei Index.

Studies have found several novel echocardiographic and Doppler measurements of RV function to be risk factors for heart failure, independently of traditional risk factors. Tei et al [6] studied, in 1995, the ability of a new Doppler index of combined systolic and diastolic function (Tei index) to separate patients with normal ventricular function from patients with heart failure. The Tei index [7] has the advantages of being less affected by age, heart rate, and preload than conventional Doppler measurements, and being calculated from 2 well-defined time intervals, and the index has an excellent reproducibility(inter observer variability<5%) [8] MPI (Myocardial perfusion Index) has been shown to have prognostic value in patients with coronary heart disease dilated cardiomyopathy, amyloidosis, coronary heart disease and symptomatic heart failure as well as in the general population. MPI provides prognostic information independently of other measurements of cardiac function and of traditional risk factors for heart failure. Therefore, MPI seem to be a clinically relevant measurement of global ventricular function and may prove to be a valuable tool in assessing the risk of developing right heart failure. MPI is a unit less number reflecting the global performance of the ventricle. It was devised in the mid 1990's (Tei et al). It is a simple index which incorporates both systolic and diastolic parameters and can be applied to either LV or RV. Several studies have used this index as a prognostic indicator of LV performance. The utility of MPI as an indicator of global RV performance is an area of interest in the recent past.

The superior predictive capacity of MPI could be explained by the fact that MPI reflects global function, while other measurements are limited to reflect mainly either LV systolic or diastolic function.

$$\frac{\text{IVRT} + \text{IVCT}}{\text{M P I}} = \text{ET}$$

According to the above equation, systolic dysfunction is characterized by the prolongation of IVCT (Isovolumetric contraction time) and decrease in ET (Ejection time). Whereas the diastolic dysfunction is characterized by the lengthening of IVRT (Isovolumetric relaxation time). Presence of both is indicated by an increase in MPI. The normal value of MPI of Left ventricle is 0.39 +/- 0.08 where as for the right heart, the normal values are 0.28 ± 0.04. Özdemir et al (2003) Fan Ying et al 2005 have demonstrated in their study that an MPI of > 0.70 may diagnose RVMI and proximal right coronary artery disease with high sensitivity and specificity.

Materials and Methods

Study Population: Those Consecutive in patients who admitted to the coronary care unit of the Dept. of Cardiology who presented with first episodes of acute inferior wall myocardial infarction presenting within 24 hours of symptom onset were included .Once the patients will meet the inclusion and exclusion criteria as defined, Informed consent was taken from the patients. The study was approved by the Institutional Ethics Committee and consent was taken from all patients.

The type of study: Prospective Observational Study.

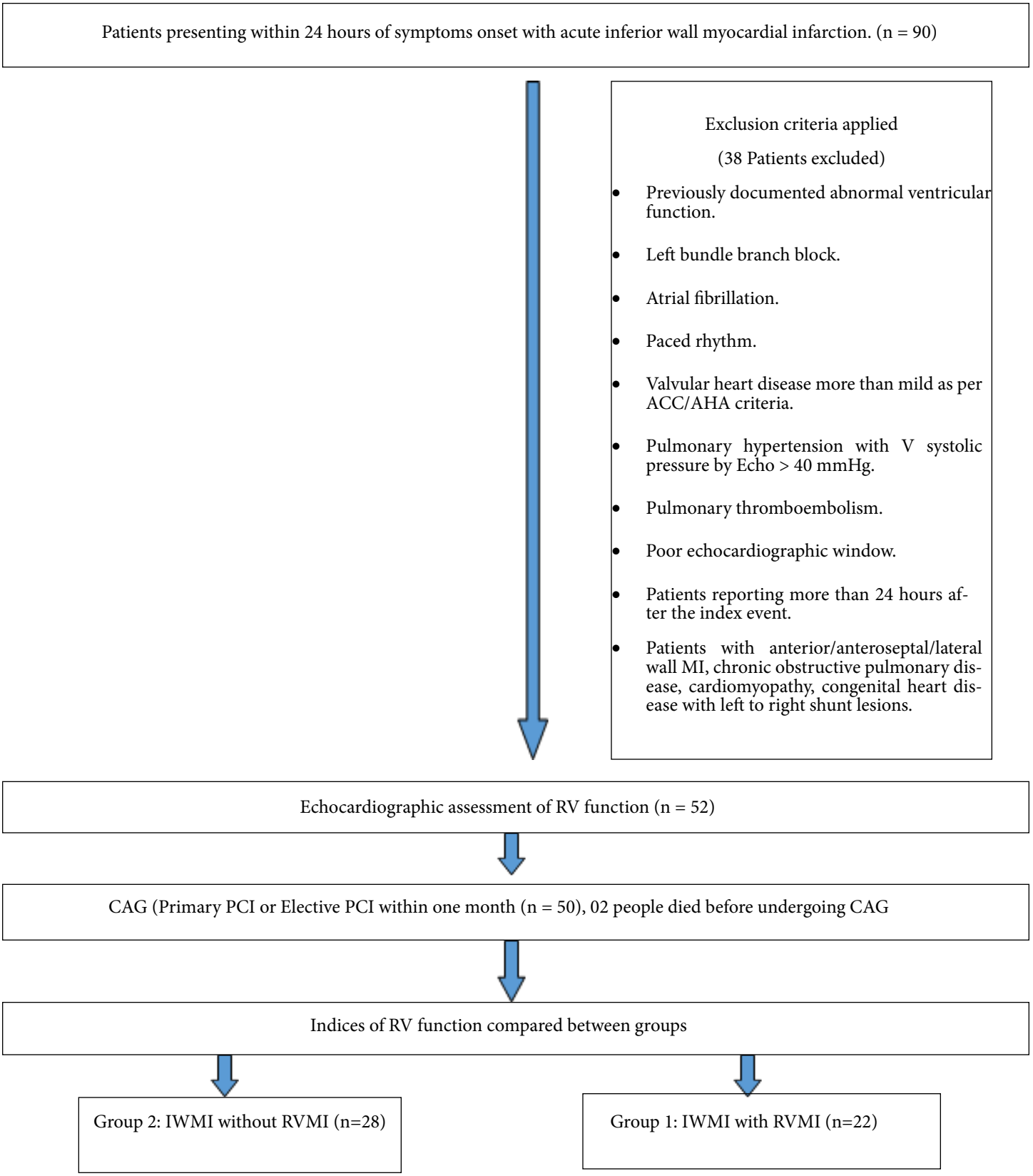
Sample size: A total of 50 patients fulfilling the Inclusion Criteria will be part of the Study.

Study Duration: From 01 June 2018 to 31 May 2019. Flow chart (Figure 1) is showing study design, inclusion and exclusion criteria and study population.

Methods

In this prospective observational study patients were subjected to detailed history taking, complete physical examination, and investigations like complete blood count, RBS (Random Blood Sugars), RFTs (Renal Function tests), fasting total cholesterol, cardiac markers like total creatine kinase (CK) and CK-MB. ECG (Electrocardiogram) was used to determine whether these patients are having RVMI or PWMI or both. All patients underwent a complete transthoracic echocardiographic study including two-dimensional, M Mode, pulsed wave Doppler and DTI using PHILIPS iE33 matrix echocardiography machine. Continuous ECG monitoring of the patients was done during the procedure with the patient lying in standard left lateral decubitus position. M mode and two-dimensional echocardiography were used to doc-

Figure1: Flow chart showing method of collection of data



ument presence or absence of pericardial effusion. The free fluid in the pericardial cavity was visualized as an echo-free space using the parasternal long axis and short axis views. Paradoxical septal motion was visualized in the parasternal long axis view. The tricuspid annular motion was recorded at the RV free wall from the apical 4-chamber view. In the real-time 2-dimensional apical 4- chamber view, the M-mode cursor was placed through the tricuspid annulus in such a way that the annulus moved along the M-mode cursor. The displacement of the tricuspid annulus was recorded in M-mode. The total displacement was measured by using the leading edge of the echoes. The presence or absence of RV wall motion abnormality was assessed qualitatively from the parasternal long-axis view, parasternal short-axis view at the level of mid-ventricle (including the anterior and posterior sites near the interventricular septum excluding the free wall because of difficulties in visualization), and apical 4-chamber view for the free wall. The wall motion was judged to be normal, hypokinetic, akinetic, dyskinetic or aneurysmal at any of the RV sites. With the use of the apical 4-chamber view, pulsed-wave Doppler trans tricuspid flow velocities were recorded by placing the sample volume between the leaflet tips in the center of the flow stream. The trans tricuspid peak rapid filling velocity (E), peak atrial filling velocity (A), E-wave deceleration time, and E/A ratio were recorded. From the apical 4-chamber view, the DTI cursor was placed at the tricuspid annulus of the RV free wall in such a way that the annulus moved along the sample volume line. During systole, a major positive velocity (Systolic 'Sm') was recorded when the annulus moved toward the cardiac apex. During diastole, when the annulus moved toward the base away from the apex, 2 major negative velocities were recorded; one during the early phase of diastole [Early diastolic (Em)] and another during the late phase of diastole [Late diastolic (Am)]. Similar measurements were recorded from the septum by placing the DTI cursor at the septal site of the annulus. Isovolumetric contraction time (IVCT), isovolumetric relaxation time (IVRT) and ejection time (ET) were measured by keeping the DTI cursor at the tricuspid annulus and subsequently RV Myocardial Performance Index (MPI) or the Tei index was calculated using the standard formula .The reference limits used for the MPI of right ventricle is 0.28 ±0.04.The reference limits for various echocardiographic indices and parameters used in this study were adopted from the standard echocardiographic manuals. Echocardiographic assessment of the patients was independently assessed by two interventional cardiologists who were blinded to Coronary anatomy, Coronary angiogram performed as a part of primary PCI or within one month of index event as an elective procedure to assess presence of a significant proximal RCA stenosis.

Coronary Angiography:

Coronary angiography was done on n = 50 patients out of n = 52. All of them underwent coronary angiography within one month of the myocardial infarction. Two people died before CAG could be planned. The coronary angiography was performed via the femoral artery route using standard sized sheaths and Judkin's left and right coronary catheters, Amplatz if necessary. The coronary angiography was considered indicative of an RVMI if an occlusion of the right coronary artery was present proximal to the acute marginal branches or the major right ventricular branches.

Statistical Analysis:

Statistical analysis was done using SPSS statistical software package version 26.0. Continuous variables are presented as mean ± SD or median if the data is unevenly distributed. Categorical variables are expressed as frequencies and percentages. The comparison of continuous variables between the groups was performed using student's t test. 'p' values were calculated and 'p' value less than 0.05 was considered as statistically significant.

Results

The results of clinical evaluation of the 50 patients with right ventricular myocardial infarction who underwent CAG subsequently either by primary PCI or elective PCI within one month collected during the study period. Patient base line Characteristics were shown in the table1. Patients who were in the time window for thrombolysis, and who had no absolute contraindications for thrombolysis were given Inj. Streptokinase I.V over 45 minutes via an infusion. All patients were treated with antiplatelet, statins, and intravenous fluid replacements whenever needed. Those who developed significant atrio-ventricular blocks were managed with temporary pacemaker implantation. Those in shock were man-

aged with fluid replacement and inotropic support. All patients were closely monitored during the intensive period. Echocardiography was done in all patients within 48 hours of symptom onset, within 24 hours whenever feasible. All patients were advised coronary angiography, and CAG was done ultimately in 50 patients within 30 days of the acute coronary unit. CAG was done through the femoral route or radial route, using properly sized sheath, and Judkin's catheter, Amplatz when necessary.

During the study period, 52 patients were evaluated and underwent a complete echo-Doppler examination. Among these patients, 21 had an RVMI, and constituted Group 1, and the remaining 29 patients had an inferior wall myocardial infarction without right ventricular involvement (Group 2). Most of the patients were in the age group of 40-60 years (32/50 = 65%).

Various complications were noted in the study patients, the commonest being conduction disturbances. Conduction disturbances were noted in 7/21 patients (34%) of Group 1, and in only 3/29 (10%) of patients in Group 2 all are complete heart blocks. Cardiogenic shock complicated 2/21 patients (9%) of Group 1, and none of the patients in Group 2. Pulmonary artery systolic pressures (PASP) >30mmHg were noted in 15/21 (69%) of Group 1, while in Group 2 patients, only 1/29 patients (3%) had PASP exceeding 30mmHg. 2 patients died due to complications, of which 2 patients belonged to Group 1 and no one belonging to Group 2. All patients died within 1 week of the acute event. Elevated pulmonary artery pressures were noted in both patients who died with a mean pulmonary artery systolic pressure of 40mmHg. We can hypothesize that patients with persisting sign of pulmonary hypertension did not experience reperfusion of the related artery and had an unfavourable course. 12 lead electrocardiography was done in all patients. Right sided chest leads and posterior wall leads were also placed and ECG recorded in all patients. By using the criteria described in methods, the culprit artery was identified as proximal RCA in 15 patients distal RCA in 22 patients Left circumflex in 13 patients. Evidence of Right ventricular involvement as defined by 1mm ST elevation in V4R was found in 18 patients (of which, 16 patients had proximal RCA as the culprit vessel on ECG and 2 had left circumflex as the vessel causing myocardial infarction).

Echocardiography was done in all 52 patients within 48 hours after the onset of the acute event, of which, echocardiography was done within 24 hours of symptom onset in 48 patients. RV end-diastolic diameter was increased in patients with RVMI, compared with those without RV involvement (Table 2), although it failed to achieve statistical significance (p=0.1). RV contraction abnormalities and IV septal motion abnormalities were noted in 41% of patients with RVMI, and only in 3% of patients without it. Significantly, the wall motion abnormalities were noted in those patients who had their echo done within 24 hours of symptom onset, stressing the fact that, the right ventricle recovers fast after an ischemic insult. Tricuspid regurgitation was noted in nearly half of the patients with right ventricular involvement; this regurgitation, when quantified by colour Doppler, was mild in a majority

Table 1 A: Baseline Patient's characteristics
GROUP1: Inferior Wall MI Patients with RVMI
GROUP2: Inferior Wall MI Patients Without RVMI

		Group 1 (n=21)	Group2 (n=29)	TOTAL
Age	<40 Yrs	3	4	50
	40-60 yrs	13	19	
	>60 yrs	5	6	
Male		17	21	38 (75%)
Female		05	07	12 (25%)
Hypertension		09	10	19 (38%)
Diabetes		12	11	23 (46%)
Dyslipedemia		08	07	15 (29%)
Smoking		16	13	29 (58%)
F/H of CAD		07	05	12 (23%)

Values are given as mean ±SD / percentages

Table 1B: Patient's baseline clinical parameters

Clinical parameters	Group1 (n=21)	Group2 (n=29)
Average age (yrs)	54 ± 11.3	51 ± 10.5
Systolic BP (mmHg)	108 ± 14	114 ± 12
Diastolic BP (mmHg)	74 ± 8	76 ± 10
Heart rate (per min)	70.1±7.4	68.3 ± 8.4
Thrombolysis with SK	14	20
CK-MB values	115 ± 40	75 ± 26

Values expressed as mean ±SD; SK = Streptokinase; CK-MB = Creatine Kinase

of cases, moderate in some and severe in none of the cases (Figure 2A-C).

The pulmonary artery systolic pressure was slightly elevated and above normal in patients of Group 1, compared to Group 2 statistically not significant(p=0.2). The tricuspid annular excursion was statistically significantly decreased in patients with right ventricular myocardial infarction, signifying that RV systolic function was depressed in those patients (p=0.05).

Myocardial performance index was found (Figure 3A-C) to be statistically significant; it is raised to nearly two-fold the reference values in patients with RVMI; the values were not much high compared to controls in those without right ventricular involvement (p=0.01). Tissue Doppler was done in the right ventricular free wall and the septal regions and the systolic (Sm), early diastolic (Em) and late diastolic (Am) velocities were noted. It was found that the right ventricular free wall Sm and Em values were statistically significantly depressed in patients with right ventricular myocardial infarction (p=0.02). The values were near normal in those without RV involvement. However, the RV free wall late diastolic velocities (Am) and the septal velocities did not differ much in patients with and without right ventricular myocardial infarction (p=0.22). Sub group analysis of this study (Figure 4A-C) Tissue Doppler was done in the right ventricular free wall and the septal regions and the systolic (Sm), early diastolic (Em) and late diastolic (Am) velocities were noted. It was found that the right ventricular free wall Sm and Em values were statistically significantly depressed in patients with right ventricular myocardial infarction (p=0.02). The values were near normal in those without RV involvement. However, the RV free wall late diastolic velocities (Am) and the septal velocities did not differ much in patients with and without right ventricular myocardial infarction (p=0.22). Ta-

Table 2: Values of various echocardiographic parameters in patients presenting with IWMI with or without RVMI

Parameters	Group1 (n=21)	Group2 (n=29)
RV EDD (mm)	32 ± 13	20 ±14
RV contraction abnormalities	09/21 (41%)	1/29 (3%)
IVS motion abnormality	07/21 (31%)	1/29 (3%)
Tricuspid regurgitation	10/21 (48%)	3/29 (10%)
PASP (mmHg)	31.8±2.7	17.1 ± 2.8
TAPSE (mm)	14.1 ± 1.2	18.2 ±0.71
MPI	0.45 ± 0.07	0.29 ± 0.02
TDI – RV Free wall Sm (cm/sec) Em	9.45 ± 0.49	12.1 ± 0.52
Am	6.8 ± 0.34	8.3 ± 0.65
	7.4 ± 0.67	9.4 ± 0.65
TDI – Septal wall (cm/sec)Sm	6.3 ± 0.5	6.2 ± 0.5

Variables represented as mean±SD; RV EDD: Right Ventricular End Diastolic Diameter; PASP: Pulmonary Artery Systolic Pressure; TAPSE:Tricuspid Annular Peak Systolic Excursion; MPI: Myocardial Perfusion Index; TDI: Tissue Doppler Imaging.

Table 3 :Echocardiographic sub group analysis revealed the following values

Sub groups In RVMI	RV EDD (mm)	TAPSE (mm)	PASP (mmHg)	Sm (cm/sec)	Em (cm/sec)	MPI
Age<40yrs	14.2 ± 4.1	14.4 ± 0.7	18 ± 4	9.5 ± 0.7	6.7 ± 0.6	0.31 ± 0.05
40-60yrs	25.1 ± 5.2	16.4 ± 0.9	28 ± 8	9.6 ± 0..6	6.7 ± 0.5	0.34 ± 0.06
60yrs	28 ± 2.1	17.2 ± 0.9	36 ± 4	9.3 ± 0.2	6.5 ± 0.1	0.38 ± 0.02
Sex -Male	22.2 ± 4.3	17.2 ± 0.8	24 ± 6	9.5 ± 0.6	6.7 ± 0.6	0.32 ± 0.05
Female	21.1 ± 5.1	16.8 ± 0.2	22 ± 4	9.3 ± 0.4	6.7 ± 0.3	0.34 ± 0.01
STK - given	18.3 ± 2.2	16.8 ± 0.4	21 ± 5	9.6 ± 0.6	6.8 ± 0.4	0.36 ± 0.04
Not given	22.1 ± 3.2	14.1 ± 0.3	31 ± 8	9.3 ± 0.7	6.7 ± 0.4	0.49 ± 0.09
Echo <24hrs	27.3 ± 5.4	14 ± 1.2	34 ± 6	9.0 ± 0.3	6.7 ± 0.3	0.51 ± 0.08
24-48 hrs.	11.1 ± 4.5	17.2 ± .9	18 ± 7	9.7 ± 0.5	6.9 ± 0.6	0.39 ± 0.1

Abbreviations: RV EDD: Right Ventricular End Diastolic Diameter; PASP: Pulmonary Artery Peak Systolic Pressure; TAPSE: Tricuspid Annulus Peak Systolic Excursion; Sm: Systolic velocity; Em: Early diastolic velocity; Am: Late diastolic velocity

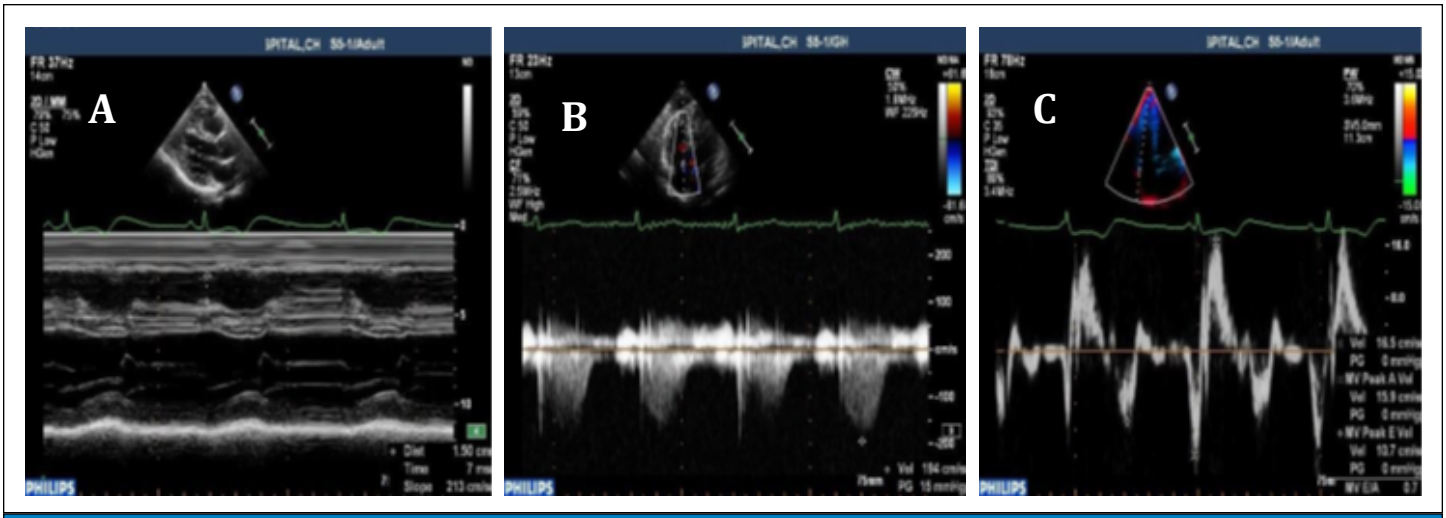


Figure 2: Tissue Doppler Imaging of RV.

Figure 2A: The measurement of RV-EDD by M-mode in PLAX (Arrow mark).
Figure 2B: Measurement of tricuspid regurgitation jet and PASP measurement using continuous Wave doppler (Arrow mark).Em and Am.Figure 2C: Tissue Doppler of RV myocardium with sample volume of RV lateral showing Sm Wave doppler (Arrow mark).Em and Am.

ble 3. Coronary angiography was done in 50 patients, of whom 21 showed right ventricular involvement by echocardiography. Out of the 50 patients, Single vessel disease was found in 26 patients Double vessel disease found in 11 patients and Triple vessel disease in 13 patients. Those who had two and three vessel disease were mostly diabetics and belonged to the>40 years' age group; even in those people, the infarct related artery was the RCA or the LCX. CAGs showing proximal RCA disease (with RVMI) and (Figure 5A-C) are CAGs showing mid RCA lesions.

Discussion

In patients with RVMI, the risk of death in hospital is high and major complications are greater. Right ventricular infarction contributes markedly to hemodynamic instability, atrio-ventricular conduction blocks, and in-hospital mortality in patients with inferior wall myocardial infarction. Systolic right ventricular function is an important predictor in the course of myocardial infarction. The poorer outcomes among patients with RVMI are not mediated entirely by RV dysfunction. Recent research points towards a new explanation for the higher complications even when the extent of RV infarction is small. Stimulation of RV vagal afferents by stretch leads to cardio-inhibitory Bezold- Jarish reflex resulting in higher than expected incidence of complications especially in the first few days after acute coronary event with RV involvement.

The pulmonary artery systolic pressure and thence the right ventricular systolic pressure was slightly elevated and above normal in patients of Group 1, compared to Group 2. In a study conducted by Alam et al [10], from the echocardiographic apical 4-chamber views, the systolic motion of the tricuspid annulus was recorded at the RV free wall with the use of 2-dimensional guided M-mode recordings. The tricuspid annular motion was reduced in inferior Ml compared with that in healthy individuals (20.5 and 25 mm, P <.001). The peak systolic velocity of the tricuspid annulus was significantly reduced in inferior Ml compared with that in healthy individuals (12 vs 14.5 cm/s, P<.001) and patients with anterior MI (12 and 14.5 cm/s, P<.001). Our study has shown that the tricuspid annular excursion was significantly decreased in patients with right ventricular myocardial infarction (14.1 ± 1.2mm Vs. 18.2 ± 0.75), signifying that RV systolic function was depressed in those patients. Alagesan R et al [11] in their study of South Indian patients with inferior wall myocardial infarction found that RV MPI was significantly elevated (from baseline of 0.20±0.05 in controls) to a mean of 0.53±0.22 in RVMI patients (p<0.001). IWMI did not elevate MPI significantly (0.21±0.17, p=NS). RV MPI >0.30 has a

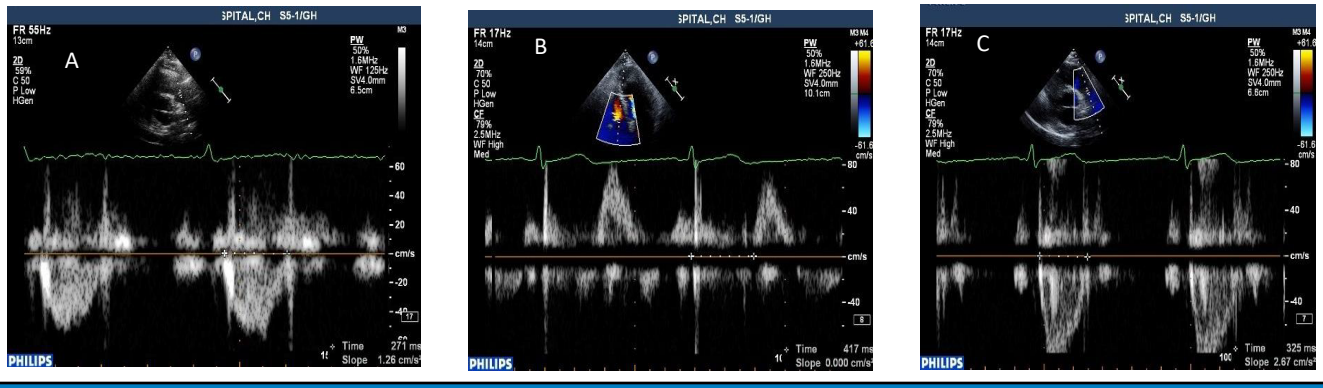


Figure 3: MPI OF RV

3A:MPI of RV in Parasternal short axis view (value B); 3B: MPI of RV in Apical 4 chamber view (value A) ; 3C: MPI of RV in Parasternal short axis view (Value B)

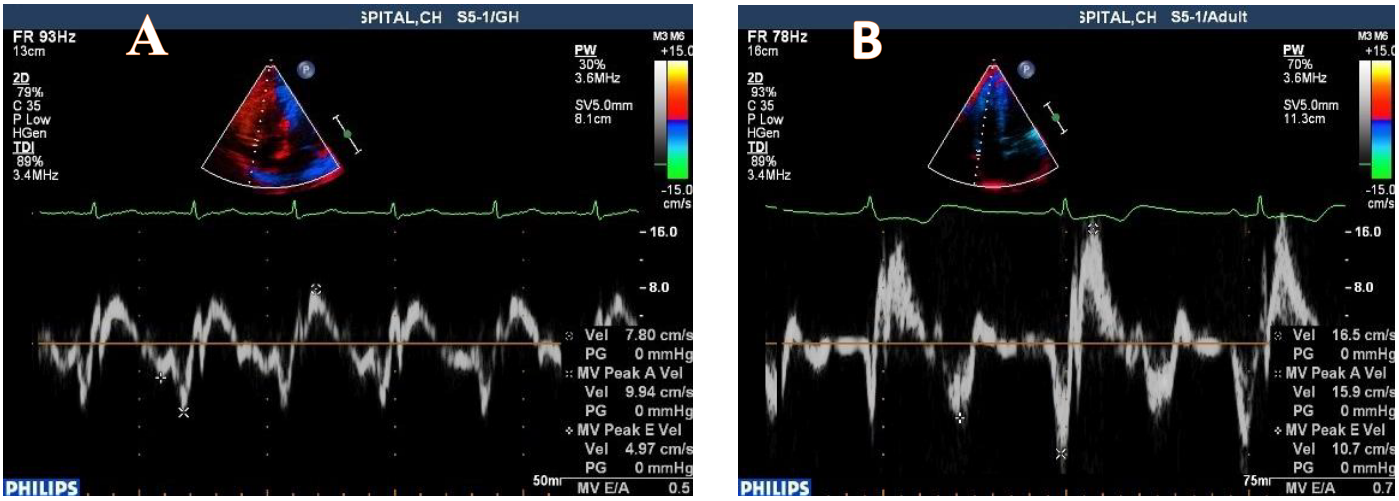


Figure 4: TDI of Lateral wall of RV

4A: TDI of lateral wall of RV in patient with IWMI with RVMI; 4B: TDI of lateral wall of RV in patient with IWMI without RVMI

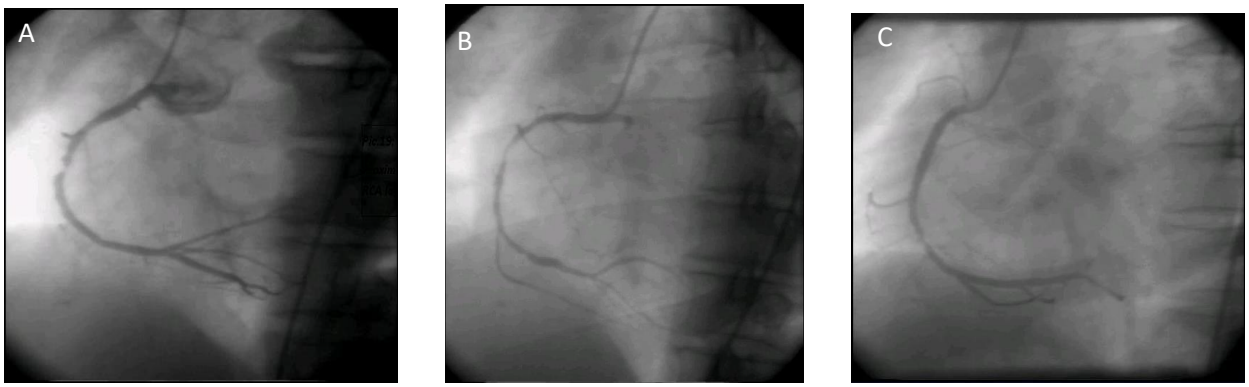


Figure 5: CAG showing RCA lesions

5A: showing Proximal RCA lesion; 5B: Showing Proximal RCAlesion; 5C: Showing Mid RCA lesion.

high sensitivity (82%) and specificity (95%) for the diagnosis of RVMI in the presence of acute IWMI. In our study, Myocardial performance index was found to be statistically significant, it was 0.45± 0.07 in patients with RVMI, compared to near normal values of 0.29 ± 0.04 in patients without right ventricular infarction. We evaluated the Tei index in patients with RVI, and we suggest that the index offers additional information on right ventricular performance in patients in the coronary care unit. We believe that this index should be measured in all patients with inferior LVI and possible involvement of right ventricle. Oguzhan et al [12] on 2004 studied 35 patients with inferior wall myocardial infarction, 14 of whom had right ventricular infarction and found that Systolic and early diastolic velocities at the lateral tricuspid annulus were significantly reduced in patients with inferior MI with RV infarction compared with those in healthy individuals (7.8 ± 1 vs. 11 ± 2 cm/s, $p < 0.002$) and patients with inferior MI without RV infarction (7.8 ± 1 vs. 10 ± 1 cm/s, $p < 0.002$). The late diastolic lateral annular velocity did not differ between the groups. Systolic and early diastolic RV free wall velocities were also significantly decreased in patients with RV infarction compared with those in healthy individuals (7 ± 1 vs. 8.7 ± 1 cm/s, $p < 0.01$; 6.3 ± 2 vs. 8.7 ± 2 cm/s, $p < 0.05$, respectively) and patients with inferior MI without RV infarction (7 ± 1 vs. 9 ± 2 cm/s, $p < 0.01$; 6.3 ± 2 vs. 8.3 ± 2 cm/s, $p < 0.05$, respectively).In our study, it was found that the right ventricular free wall Sm, Em, Am values were statistically significantly depressed in patients with right ventricular myocardial infarction compared to those without RV involvement. (Sm 9.4 ± 0.7 Vs. 12.1 ± 1.1; Em 6.8 ± 0.7 Vs. 8.3 ± 1.0; (Am 7.4 ± 1.1 Vs. 9.4 ± 1.2). However, there is no significant difference between septal velocities in patients with and without right ventricular myocardial infarction; (Septal velocities 6.4 ± 0.9 Vs. 6.2 ±0.8). Echo identified RVMI in 9 patients who did not show RVMI on ECG, and this was confirmed by CAG.11 patients with RVMI ECG did not have evidence of RVMI on echo as well as on CAG. According to Goldstein et al [13] acute RCA occlusion proximal to the RV branches results in RV free wall dysfunction, exerting mechanically disadvantageous effects on biventricular performance. Depressed RV systolic function decreases trans pulmonary delivery of left ventricular (LV) preload, resulting in diminished cardiac output. The ischemic right ventricle is stiff, dilated, and volume dependent, resulting in pan diastolic RV dysfunction and septally mediated alterations in LV compliance, which are exacerbated by elevated intra pericardial pressure. Under these conditions, RV pressure generation and output are dependent on LV septal contractile contributions, governed by both primary septal contraction and paradoxical septal motion. When the culprit coronary lesion is distal to the right atrial (RA) branches, augmented RA contractility enhances RV performance and optimizes cardiac output. Conversely, more proximal occlusions result in ischemic depression of RA contractility, which impairs RV filling and performance, resulting in more severe hemodynamic compromise. Similarly, in our study also we found that there is significant correlation between proximal RCA stenosis and patient presentation with RVMI. About 70% of proximal RCA stenosis patients had RVMI compared with those without RVMI. Hence whenever a patient present with RVMI we should consider possibility of proximal RCA stenosis with high index of suspicion.

Summary and Conclusions

On tissue Doppler imaging, right ventricular free wall systolic velocity and early diastolic velocity in patients with RVMI was less compared to patients without RVMI and the correlation was statistically significant. Right ventricular septal velocities did not correlate well with RV dysfunction. Right ventricular myocardial performance index (Tei index) correlated with RV dysfunction and attained statistical significance. Increased MPI values were also associated with higher mortality. Right ventricular dimension and regional wall motion abnormalities were insignificant in detecting RVMI.RV dysfunction was worse in those whose echo was done within 24 hrs. when compared with those done after, showing that RV function improves with time. Thrombolysed patients had lower Myocardial performance index values, compared to those who were not thrombolysed. Age and sex did not significantly correlate with right ventricular function after a myocardial infarction. Echo can identify right ventricular dysfunction in patients who have no or doubtful findings of RVMI on ECG. Coronary angiogram revealed that most of the patients who showed features suggestive of Right ven-

tricular dysfunction on echocardiography showed proximal RCA lesion, hence we can conclude that the more the proximal stenosis the higher the chances of Right ventricular dysfunction and the more fatal the outcome of the patient. Echocardiographic assessment of various parameters of RV function showed significant differences between those with and those without proximal RCA lesion. Non-invasive modalities specifically 2D echocardiography and using parameters like tissue Doppler systolic annular velocity, myocardial performance index and TAPSE which are relatively easy to perform are useful in predicating proximal RCA as infract related artery.

Limitations of The Study

1. Our study included relatively small number of patients to evaluate clinical outcomes.

2. Analysis of LV MPI (Left Ventricular Myocardial Performance Index) was not part of our study. This may also significantly contribute to overall hemodynamics in RV MPI (Right Ventricular Myocardial Infarction) assessment in RVMI (Right Ventricular Myocardial Infarction).

3. Myocardial velocities obtained by TDI (Tissue Doppler Imaging) in the apical 4 chambers reflect the movements of the myocardium only along the long axis. The contraction of the ventricular circumferential fibers does affect the TDI.

4. Tricuspid annular movements do not represent the function of the entire RV myocardium.

5. Even though echocardiography was performed within the first 48 hours after IWMI (Inferior Wall Myocardial Infarction), it is possible that some patients may have already recovered from the damage in the right ventricle.

6. Magnetic resonance imaging which is the gold standard for right ventricular function was not done in our cases, due to financial constraints.

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