

Right Ventricular Dysfunction in Patients with Acute STEMI, Radionuclide-Based Assessment

Samir El-Hadidy¹, Abdalla Mohammed¹, Shaaban Alramlawy², Waheed Radwan¹, Mohamed Affify¹

¹Critical Care Medicine Department, Cairo, Egypt

²Biophysics Department, Faculty of Medicine, Cairo University, Cairo, Egypt

Email: samirelhadidy81@yahoo.com

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Abstract

Background: An acute myocardial infarction, particularly one that is large and transmural, can produce alterations in the topography of both the infarcted and noninfarcted regions of the ventricle. Cardiac remodeling after acute myocardial infarction (AMI) is characterized by molecular and cellular mechanisms involving both left and right ventricles. **Objective:** To study the right ventricular affection in patients with acute myocardial infarction of the left ventricle and treated with primary PCI. **Methods:** The study was done in the critical care department, Cairo University (in which 2,500 primary percutaneous coronary interventions (PCIs) are done annually). Forty patients with acute ST-elevation myocardial infarction (STEMI) were subjected to primary (PCI), we excluded all patients with RV infarction and patients with pulmonary hypertension. RV function was assessed by first pass radionuclide angiocardigraphy within 48 hours of admission. **Results:** Regarding the incidence of right ventricular dysfunction in patients with acute left ventricular STEMI who treated with 1ry PCI, there were 21 patients (52.5%) with RV EF% < 40%, 16 patients (40%) with RV peak emptying rate (PER) < 1.9 EDV/s, 18 patients (45%) with RV peak filing rate (PFR) < 2.5 EDV/s and 19 patients (47.5%) with RV time to peak filling rate (TPFR) > 180 msec. There was a significant relationship between right ventricular dysfunction and duration of ICU stay, impairment of LV systolic function, failure of complete resolution of ST segment elevation, failure of early peaking of cardiac enzymes, occurrence of in-hospital complications and one year mortality. **Conclusion:** The incidence of right ventricular dysfunction in patients with acute left ventricular STEMI is higher than expected and has a negative impact on their outcome.

Keywords

STEMI, RV Affection, First Pass, Radionuclide

1. Introduction

The LV and RV are working as a “functional syncytium” and the two ventricles cannot be dissociated in an independent manner.

Knowledge about the role of the right ventricle in health and disease historically has lagged behind that of the left ventricle.

More precise characterization of right ventricular function should improve our understanding of pathophysiology and permit more rational management of cardiac disorders.

An acute myocardial infarction, particularly one that is large and transmural, can produce alterations in the topography of both the infarcted and noninfarcted regions of the ventricle [1].

The mechanisms leading to RV dysfunction following AMI involving the LV are not completely clear, but it is frequently assumed that LV failure causes pulmonary hypertension (PH) and increased RV afterload leading to RV remodeling and dysfunction. In addition, infarction or ischemia of the RV and/or the septum is common in patients with AMI and can also contribute to abnormal RV systolic function, and also neurohormonal activation or inflammation may be involved in subtle right ventricular affection in patients with acute MI.

RV remodeling and dysfunction following AMI are a part of a global biventricular remodeling response due to altered wall stress which is further aggravated by neurohormonal activation during and after AMI. Cardiac remodeling after acute myocardial infarction (AMI) is characterized by molecular and cellular mechanisms involving both left and right ventricles, and biventricular failure identifies patients with an extremely unfavorable prognosis [1].

Data on the association between right ventricular (RV) function and adverse events after acute myocardial infarction (AMI) are scarce and the association between right ventricular function and other clinical outcomes after MI was less clear.

Post-infarction cardiac remodeling leading to HF represents a “dangerous intersection” in AMI patients, and biventricular failure is considered to be the terminal stage of cardiac remodeling.

It was found that impaired right ventricular function is an adverse prognostic factor in patients with inferior infarction, particularly in those with impaired left ventricular function.

Evaluation of RV structure and function in patients with cardiopulmonary disorders became a vital step in the management. Many tools are available for right ventricular assessment beside the clinical examination and electrocardiogram (ECG); echocardiography gives a good evaluation of RV structure and function [2]. Radionuclide-based techniques provide reliable and geometrically independent assessments of RVEF. Cardiac magnetic resonance imaging (MRI) is increasingly used as a tool in the evaluation of right ventricle [3] [4].

2. Methods

The study was conducted on forty patients admitted to the critical care department, Cairo University with acute STEMI and subjected to primary PCI. Our study was done within 48 hours of admission.

Inclusion criteria:

All patients who experienced acute ST-segment elevation myocardial infarction (STEMI) and subjected to primary percutaneous coronary intervention (PCI) of the infarct-related artery (IRA) were included in the study within 48 hours of admission.

Exclusion criteria:

- Patients with a coexisting RV infarction who were diagnosed by 12 leads ECG with recorded right-sided leads.
- Patients received thrombolytic therapy.
- Atrial fibrillation.
- Pulmonary hypertension, PH was defined as an estimated PASP \geq 35 mmHg [5].
- A pacemaker wire in the right ventricle.
- Patients who had been diagnosed with non-ischemic dilated cardiomyopathy before the onset of MI.

The following data were obtained from all patients and included in the current work: Personal data (name, age and gender), Medical history, date, cause of admission and chest pain duration before admission.

Routine laboratory tests and Serial cardiac enzymes (creatine kinase, the CK-MB isoenzyme, troponin T and lactate dehydrogenase enzyme) and we noticed the early peaking of cardiac enzymes if there was an abrupt initial increase of creatine kinase levels, more than two-fold over the upper normal or baseline elevated values at two hours of reperfusion therapy.

Twelve leads ECG was obtained with right sided leads were recorded if inferior MI was present. We document the rhythm and the site of MI.

Right ventricular infarction is suggested by the presence of:

- ST elevation in V1, ST elevation in lead III > lead II.
- ST elevation in V1 > V2.
- ST elevation in V1 + ST depression in V2.

Right ventricular infarction is confirmed by the presence of ST elevation in the right-sided leads (V3R-V6R).

The reduction of sum of ST segment elevation after primary PCI was documented, and graded it in 3 categories:

- \geq 50% reduction of sum of ST segment elevation.
- 20% - 50% reduction of sum of ST segment elevation.
- <20% reduction of sum of ST segment elevation.

Radionuclide-based techniques:

Assessments of the left and right ventricular function by technetium-99 m first pass radionuclide angiography.

We analyzed the initial transit of intravenously injected technetium-99 m bolus as it traverses the central circulation by the gamma camera and assessed biventricular systolic function, ventricular volume measurements and ventricular compliance through peak filling and emptying rates.

A large proximal vein in the right ante-cubital fossa was cannulated with a large gauge cannula, Electrocardiography (ECG) gated list mode acquisition was done]. Acquisition was started a few seconds before the injection. Simultaneous biplanar acquisition with a double-headed camera has been done. The acquisition duration was about 30 seconds, in order to allow for complete transition through the central circulation.

Finally, we observe the course of the patient as regard occurrence of in-hospital complications, duration of ICU stay and the mortality (in-hospital, 28-days and one year mortality).

Statistical analysis of the data, data were coded and entered using the statistical package SPSS (Statistical Package for the Social Sciences) version 24. Data were summarized using mean, standard deviation, median, minimum and maximum in quantitative data and using frequency (count) and relative frequency (percentage) for categorical data. Comparisons between quantitative variables were done using the non-parametric Mann-Whitney test [6]. For comparing categorical data, Chi-square (χ^2) test was performed. Exact test was used instead when the expected frequency is less than 5 [7]. P-values less than 0.05 were considered as statistically significant.

3. Results

Our study included forty patients (32 men and 8 women) aged 54 ± 10 years admitted to ICU with acute STEMI and treated with primary PCI (**Table 1** & **Table 2**), of whom 17 patients (42.5%) were diabetic, 13 patients (57.5%) were hypertensive, 32 patients (80%) were smokers, 23 patients (57.5%) had dyslipidemia, 8 patients (20%) had past history of ischemic heart disease and 16 patients (40%) had family history of ischemic heart disease (**Table 3**). The mean duration of chest pain before admission to the ICU was 4.43 ± 1.89 hours. The mean Door to Balloon duration was 2.1 ± 0.53 hours. The mean duration of ICU stay in our study was 6.45 ± 2.53 days (**Table 4**). During hospitalization, 14 patients (35%) developed in-hospital complications (cardiogenic shock, arrhythmias and recurrent ischemia) while the rest of patients had a smooth course (**Table 5** and **Figure 1**). Three patients developed cardiogenic shock, five patients suffered from recurrent ischemia and six patients developed arrhythmias (4 patients developed atrial fibrillation, 1 patient developed non-sustained ventricular tachycardia and 1 patient developed sustained ventricular tachycardia) (**Table 6**).

Cardiogenic shock was defined in our study based on the following established clinical criteria: 1) Hypotension-systolic blood pressure < 90 mmHg for more than 30 min or the need for vasopressor/mechanical support to achieve this blood pressure; 2) evidence of end-organ hypoperfusion with at least one of

the following: altered mental status, cold clammy skin or extremities, urine out-put less than 30 ml/h, or elevated serum lactate greater than 2 mmol/L [8]. Recurrent ischemia defined as the persistence of chest pain due to myocardial ischemia after revascularization.

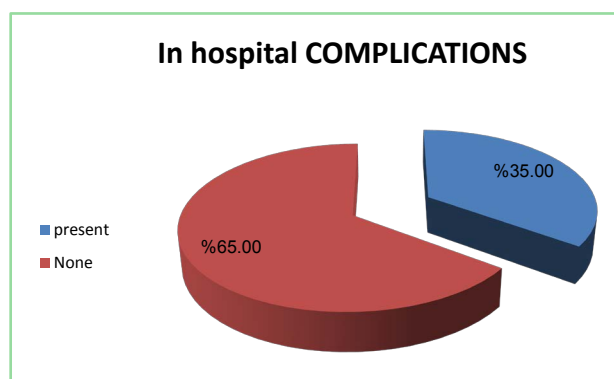


Figure 1. Incidence of in-hospital complications. Three patients developed cardiogenic shock, five patients suffered from recurrent ischemia and six patients developed arrhythmias (4 patients developed atrial fibrillation, 1 patient developed non-sustained ventricular tachycardia and 1 patient developed sustained ventricular tachycardia).

Table 1. Demographic characteristics—Age.

	Mean	Standard Deviation	Median	Minimum	Maximum
Age	54.02	10.19	53.50	33.00	76.00

Table 2. Demographic characteristics—Gender.

		Count	%
Gender	Male	32	80.0%
	Female	8	20.0%

Table 3. Clinical characteristics of the participants.

		Count	%
DM	DM	17	42.5%
	Not diabetic	23	57.5%
HTN	Hypertensive	13	32.5%
	Normotensive	27	67.5%
Smoking	Smoker	32	80.0%
	Not smoker	8	20.0%
Dyslipidemia	Dyslipidemia	23	57.5%
	Normal	17	42.5%
IHD (Previous ACS)	Positive history	8	20.0%
	N0 history	32	80.0%
Family history	Positive history	16	40.0%
	N0 history	24	60.0%

Table 4. Duration of ICU stay.

	Mean	Standard Deviation	Median	Minimum	Maximum
ICU Stay (days)	6.45	2.53	6.00	3.00	18.00

Table 5. Incidence of in-hospital complications.

	Count	%
(In hospital COMPLICATIONS)	Present	14 35.0%
	None	26 65.0%

Table 6. The developed in-hospital complications.

	Count	%
Cardiogenic shock	Shocked	3 7.5%
	Non shocked	37 92.5%
Recurrent ischemia	Patients developed ischemia	5 12.5%
	Patients did not develop ischemia	35 87.5%
Arrhythmias	Patients developed arrhythmias	6 15%
	Patients did not develop arrhythmias	34 85%

Coronary angiographic data:

Infarct related artery (IRA) was left anterior descending artery (LAD) in 30 patients (75%), right coronary artery (RCA) in 8 patients (20%) and left circumflex artery (LCX) in only 2 (5%) patients. There was one lesion in 16 patients (40%), two lesions in 17 patients (42.5%) and three lesions in 7 patients (17.5%). We found that TIMI flow was 0 (pre PCI) in all patients, II (post PCI) in 9 patients (22.5%) and III (post PCI) in 31 patients (77.5%) (**Table 7**).

No documented in-hospital and 28-days mortality while in one year, 2 mortalities were identified (**Table 8**).

First pass radionuclide angiocardigraphy results revealed that the mean LV EF% was $40.44\% \pm 8.75\%$ and the LV peak emptying rate (PER) was 2.28 ± 0.64 EDV/s, the mean LV peak filling rate (PFR) was 2.84 ± 1.03 EDV/s, the time to peak filling rate (TPFR) was 180 ± 50 msec., the mean RV EF% was $36.68\% \pm 8.43\%$ and the RV peak emptying rate (PER) was 2.28 ± 0.62 EDV/s, the mean RV peak filling rate (PFR) was 2.39 ± 1.05 EDV/s and the time to peak filling rate (TPFR) was 179.32 ± 48 msec (**Table 9 & Figure 2 & Figure 3**).

On studying the incidence of right ventricular dysfunction among these patients, we found that there were 21 patients (52.5%) with RV EF% < 40%, 16 patients (40%) with RV peak emptying rate (PER) < 1.9 EDV/s, 18 patients (45%) with RV peak filling rate (PFR) < 2.5 EDV/s and 19 patients (47.5%) with RV time to peak filling rate (TPFR) > 180 msec (**Table 10 & Figure 4**).

On studying the relation between the site of MI and the right ventricular affection, there was no statistically significant difference. Also on studying the re-

lation between the Infarct related artery (IRA) and the right ventricular dysfunction, there was no statistically significant difference (**Table 11**).

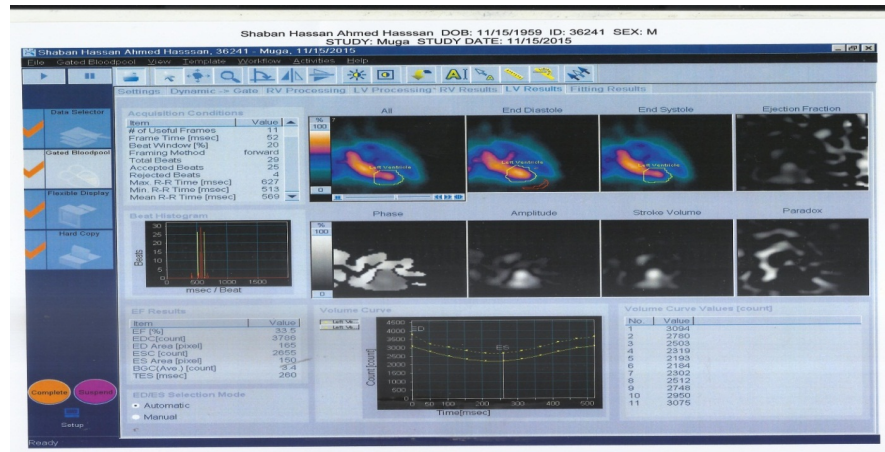


Figure 2. First pass radionuclide angiography: Time activity curve.

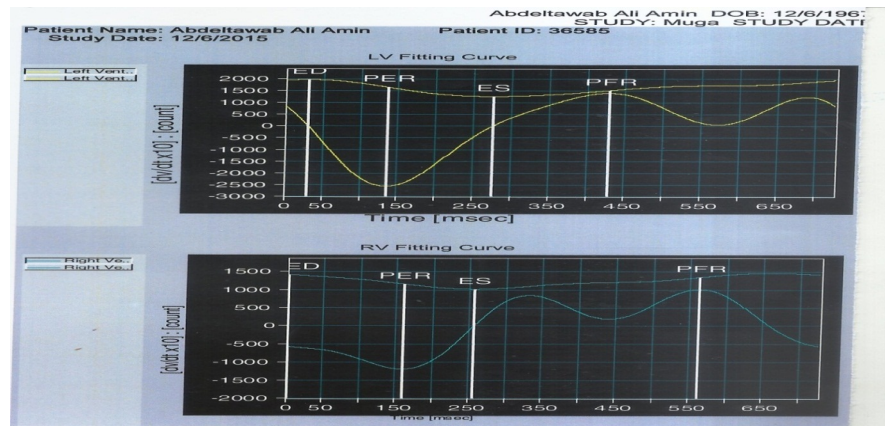


Figure 3. First pass radionuclide angiography: LV & RV fitting curves.

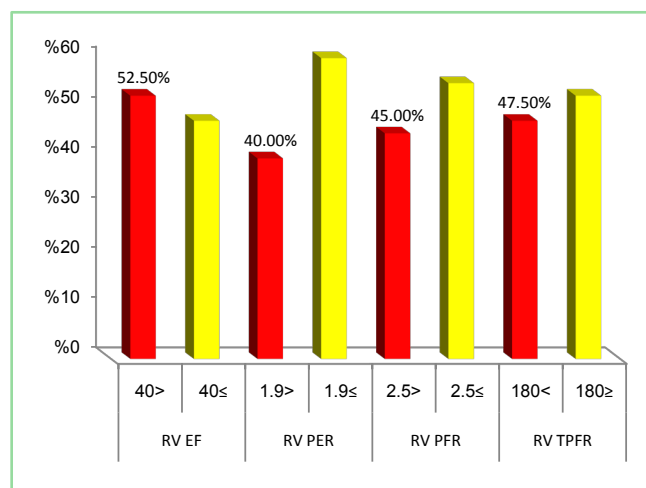


Figure 4. Incidence of right ventricular dysfunction in patients with acute STEMI after 1ry PCI. EF: Ejection fraction, PER: Peak emptying rate, PFR: Peak filling rate, RV: Right ventricle, TPFR: Time to peak filling rate.

Table 7. Coronary angiographic data.

		Count	%
IRA	(LAD)	30	75%
	(LCX)	2	5.0%
	(RCA)	8	20.0%
Number of Significant lesions on angiography	One significant lesion	16	40.0%
	Two significant lesions	17	42.5%
	Three significant lesions	7	17.5%
Post PCI TIMI flow grade	TIMI flow II	9	22.5%
	TIMI flow III	31	77.5%

LAD: Left anterior descending artery, LCX: Left circumflex artery, RCA: Right coronary artery.

Table 8. The mortality.

		Count	%
In-hospital Mortality	Non-survivors	0	0.0%
	survivors	40	100.0%
28 days Mortality	Non-survivors	0	0.0%
	survivors	40	100.0%
One year mortality	Non-survivors	2	5.0%
	survivors	38	95.0%

Table 9. First pass radionuclide angiography results.

	Mean	Standard Deviation	Median	Minimum	Maximum
LV EF [%]	40.44	8.75	41.00	20.00	60.00
LV PER (EDV/s)	2.28	.64	1.95	1.50	3.60
LV PFR (EDV/s)	2.84	1.03	2.55	1.60	4.80
LV TPFPR [msec]	180.08	50.05	183.00	106.00	362.00
RV EF [%]	36.68	8.43	37.00	20.40	51.00
RV PER (EDV/s)	2.28	.62	2.00	1.50	3.70
RV PFR (EDV/s)	2.93	1.05	2.65	1.50	5.00
RV TPFPR [msec]	179.32	49.08	177.00	105.00	328.00

EF: Ejection fraction, PER: Peak emptying rate, PFR: Peak filling rate, RV: Right ventricle, TPFPR: Time to peak filling rate.

Table 10. Percentage of Right ventricular affection in patients with acute STEMI after 1ry PCI (by first pass radionuclide angiography).

		Count	%
RV EF	<40	21	52.5%
	≥40	19	47.5%
RV PER	<1.9	16	40.0%
	≥1.9	24	60.0%
RV PFR	<2.5	18	45.0%
	≥2.5	22	55.0%
RV TPFPR	>180	19	47.5%
	≤180	21	52.5%

EF: Ejection fraction, PER: Peak emptying rate, PFR: Peak filling rate, RV: Right ventricle, TPFPR: Time to peak filling rate.

Table 11. Right ventricular affection and Infarct related artery (IRA).

		IRA						P-value
		LAD		LCX		RCA		
		Count	%	Count	%	Count	%	
RV EF	<40	18	60.0%	0	0.0%	3	37.5%	0.219
	≥40	12	40.0%	2	100.0%	5	62.5%	
RV PER	<1.9	15	50.0%	0	0.0%	1	12.5%	0.090
	≥1.9	15	50.0%	2	100.0%	7	87.5%	
RV PFR	<2.5	17	56.7%	0	0.0%	1	12.5%	0.060
	≥2.5	13	43.3%	2	100.0%	7	87.5%	
RV TPFPR	>180	17	56.7%	0	0.0%	2	25.0%	0.109
	≤180	13	43.3%	2	100.0%	6	75.0%	

EF: Ejection fraction, PER: Peak emptying rate, PFR: Peak filling rate, RV: Right ventricle, TPFPR: Time to peak filling rate.

There was a statistically significant relation between Rt ventricular dysfunction and the duration of ICU stay, we observed that patients with right ventricular dysfunction had a prolonged ICU stay, P-values are 0.008, 0.009, 0.003 and 0.016 (Table 12 & Figure 5).

It was found that right ventricular dysfunction in our patients was related to the impairment of LV systolic function, and the relation was statistically significant ($P < 0.001$) (Table 13).

We found that the right ventricle was more affected with post PCI TIMI flow II than post PCI TIMI flow III as observed from RV EF, PER and PFR (P-value = 0.021, 0.018 and 0.006 respectively) (Table 14).

We noticed also that the right ventricle was more affected with failure of resolution of ST segment after the primary PCI ($P < 0.05$), and with failure of occurrence of early peaking of cardiac enzymes ($P \leq 0.001$) (Table 15 & Table 16).

There was a statistically significant relation between RT ventricular dysfunction and in-hospital complications (P-values are 0.002, 0.003, 0.001 and 0.004) (Table 17 & Figure 6). There was a relation between right ventricular affection and the one year mortality but it did not reach the statistically significant value, $P \geq 0.05$ (Table 18 & Figure 7).

4. Discussion

The right ventricle (RV) has historically received less attention than its counterpart of the left side of the heart, yet there is a substantial body of evidence showing that RV size and function are perhaps equally important in predicting adverse outcomes in cardiovascular diseases [9] [10] [11].

Ventricular function can be assessed with radionuclide techniques by two methods, first-pass radionuclide angiography and equilibrium radionuclide angiography (ERNA) [12]. Both techniques have the advantage of being independent of geometric assumption and have been validated extensively.

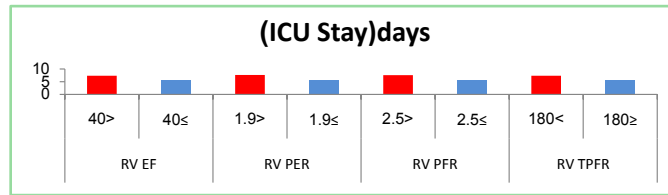


Figure 5. Right ventricular affection and duration of ICU stay. EF: Ejection fraction, PER: Peak emptying rate, PFR: Peak filling rate, RV: Right ventricle, TPFR: Time to peak filling rate.

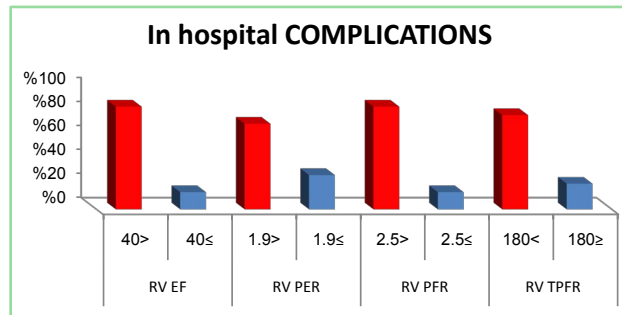


Figure 6. Relation of right ventricular affection and occurrence of in-hospital complications. EF: Ejection fraction, PER: Peak emptying rate, PFR: Peak filling rate, RV: Right ventricle, TPFR: Time to peak filling rate.

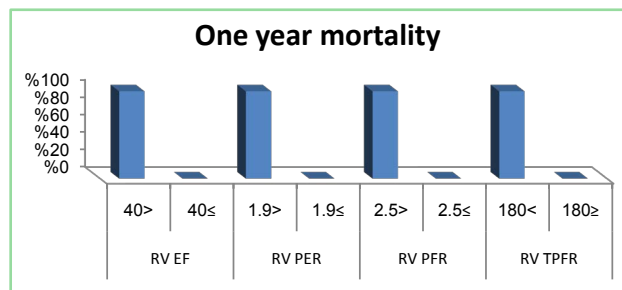


Figure 7. Right ventricular affection and one year mortality. EF: Ejection fraction, PER: Peak emptying rate, PFR: Peak filling rate, RV: Right ventricle, TPFR: Time to peak filling rate.

Table 12. Right ventricular affection and duration of ICU stay.

		ICU Stay (days)					P-value
		Mean	SD	Median	Minimum	Maximum	
RV EF	<40	7.33	2.92	7.00	3.00	18.00	0.008
	≥40	5.47	1.58	5.00	3.00	9.00	
RV PER	<1.9	7.62	3.20	7.00	3.00	18.00	0.009
	≥1.9	5.67	1.61	5.00	3.00	9.00	
RV PFR	<2.5	7.61	3.05	7.00	3.00	18.00	0.003
	≥2.5	5.50	1.50	5.00	3.00	9.00	
RV TPFR	>180	7.37	3.00	7.00	3.00	18.00	0.016
	≤180	5.62	1.69	5.00	3.00	9.00	

EF: Ejection fraction, PER: Peak emptying rate, PFR: Peak filling rate, RV: Right ventricle, TPFR: Time to peak filling rate.

Table 13. Right ventricular affection and impairment of LV systolic function (EF%).

		LV EF [%]					P-value
		Mean	Standard Deviation	Median	Minimum	Maximum	
RV EF	<40	34.11	6.63	35.80	20.00	47.70	<0.001
	not < 40	47.43	4.34	47.00	42.00	60.00	
RV PER	<1.9	33.48	6.54	35.40	20.00	40.00	<0.001
	not < 1.9	45.08	6.77	46.50	29.00	60.00	
RV PFR	<2.5	32.97	6.17	35.00	20.00	40.00	<0.001
	not < 2.5	46.55	4.94	47.00	37.10	60.00	
RV TPFR	>180	33.67	6.08	35.80	20.00	40.00	<0.001
	not > 180	46.56	5.76	47.00	29.00	60.00	

EF: Ejection fraction, PER: Peak emptying rate, PFR: Peak filling rate, RV: Right ventricle, TPFR: Time to peak filling rate.

Table 14. Right ventricular and TIMI flow (post PCI).

		Post PCI TIMI flow grade				P-value
		TIMI flow II		TIMI flow III		
		Count	%	Count	%	
RV EF	<40	8	88.9%	13	41.9%	0.021
	≥40	1	11.1%	18	58.1%	
RV PER	<1.9	7	77.8%	9	29.0%	0.018
	≥1.9	2	22.2%	22	71.0%	
RV PFR	<2.5	8	88.9%	10	32.3%	0.006
	≥2.5	1	11.1%	21	67.7%	
RV TPFR	>180	7	77.8%	12	38.7%	0.060
	≤180	2	22.2%	19	61.3%	

EF: Ejection fraction, PER: Peak emptying rate, PFR: Peak filling rate, RV: Right ventricle, TPFR: Time to peak filling rate.

Table 15. Right ventricular affection and ST segment elevation resolution after the primary PCI.

		ST elevation resolution (ECG)						P-value
		<20%		20% - 50%		>50%		
		Count	%	Count	%	Count	%	
RV EF	<40	6	100.0%	13	81.2%	2	11.1%	<0.001
	≥40	0	0.0%	3	18.8%	16	88.9%	
RV PER	<1.9	4	66.7%	10	62.5%	2	11.1%	0.002
	≥1.9	2	33.3%	6	37.5%	16	88.9%	
RV PFR	<2.5	6	100.0%	10	62.5%	2	11.1%	<0.001
	≥2.5	0	0.0%	6	37.5%	16	88.9%	
RV TPFR	>180	6	100.0%	11	68.8%	2	11.1%	<0.001
	≤180	0	0.0%	5	31.2%	16	88.9%	

EF: Ejection fraction, PER: Peak emptying rate, PFR: Peak filling rate, RV: Right ventricle, TPFR: Time to peak filling rate.

Table 16. Right ventricular affection and Early peaking of cardiac enzymes after primary PCI.

		Eary peaking after PCI				P-value
		Yes		No		
		Count	%	Count	%	
RV EF	<40	9	32.1%	12	100.0%	<0.001
	≥40	19	67.9%	0	0.0%	
RV PER	<1.9	5	17.9%	11	91.7%	<0.001
	≥1.9	23	82.1%	1	8.3%	
RV PFR	<2.5	6	21.4%	12	100.0%	<0.001
	≥2.5	22	78.6%	0	0.0%	
RV TPFPR	>180	8	28.6%	11	91.7%	<0.001
	≤180	20	71.4%	1	8.3%	

EF: Ejection fraction, PER: Peak emptying rate, PFR: Peak filling rate, RV: Right ventricle, TPFPR: Time to peak filling rate.

Table 17. Relation of right ventricular affection and in-hospital complications.

		(In hospital COMPLICATIONS)				P-value
		Yes		No		
		Count	%	Count	%	
RV EF	<40	12	85.7%	9	34.6%	0.002
	≥40	2	14.3%	17	65.4%	
RV PER	<1.9	10	71.4%	6	23.1%	0.003
	≥1.9	4	28.6%	20	76.9%	
RV PFR	<2.5	12	85.7%	6	23.1%	<0.001
	≥2.5	2	14.3%	20	76.9%	
RV TPFPR	>180	11	78.6%	8	30.8%	0.004
	≤180	3	21.4%	18	69.2%	

EF: Ejection fraction, PER: Peak emptying rate, PFR: Peak filling rate, RV: Right ventricle, TPFPR: Time to peak filling rate.

Table 18. Right ventricular affection and one year mortality.

		One year mortality				P-value
		alive		dead		
		Count	%	Count	%	
RV EF	<40	19	50.0%	2	100.0%	0.488
	≥40	19	50.0%	0	0.0%	
RV PER	<1.9	14	36.8%	2	100.0%	0.154
	≥1.9	24	63.2%	0	0.0%	
RV PFR	<2.5	16	42.1%	2	100.0%	0.196
	≥2.5	22	57.9%	0	0.0%	
RV TPFPR	>180	17	44.7%	2	100.0%	0.219
	≤180	21	55.3%	0	0.0%	

EF: Ejection fraction, PER: Peak emptying rate, PFR: Peak filling rate, RV: Right ventricle, TPFPR: Time to peak filling rate.

The first-pass technique has the disadvantage of having a lower count density, technical difficulties, whereas the equilibrium technique has difficulty separating the right atrium from the right ventricle and has no benefits for the long-term follow up and the clinical application due to the large dosage and long collection duration [13]. There are some obvious advantages with first pass study as the acquisition of data in less than 30 seconds; determination of RV function with less overlap of activity in other chambers; the use of multiple radiopharmaceuticals and the ability to obtain high-quality studies in even morbidly obese individuals [14].

In our study, on determining the incidence of right ventricular dysfunction among the patients with acute MI after 1ry PCI, we found that there were 21 (52.5%) patients with RV EF% < 40%, 16 (40%) patients with RV peak emptying rate (PER) < 1.9 EDV/s, 18 (45%) patients with RV peak filing rate (PFR) < 2.5 EDV/s and 19 (47.5%) patients with RV time to peak filling rate (TPFR) > 180 msec. In the study done by Polak J. F. *et al.* [15], the predictive value of radionuclide ventriculography was studied in 34 patients with atherosclerotic coronary artery disease, when a right ventricular ejection fraction of less than 35% was used as a discriminant, there were 21 patients (62%) with a depressed right ventricular ejection fraction. In the study done by Jensen C. J. *et al.* in year 2010 [16], Fifty patients with first-ST-segment elevation MI underwent 1.5-T cardiac MRI immediately after successful percutaneous coronary intervention. Right ventricular involvement was diagnosed with cardiac MRI in 27 patients (54%).

In our study, there was a significant statistical relation between RT ventricular dysfunction and the duration of ICU stay, we observed that patients with right ventricular dysfunction had a prolonged ICU stay, P-values are 0.008, 0.009, 0.003 and 0.016 for radionuclide parameters. *In disagreement with our data* is the study of Jensen C. J. *et al.* in year 2010 [16] in which they found that duration of ICU treatment did *not differ significantly* between the group with and that without RV involvement (3 ± 0.9 , 2.7 ± 0.9 respectively P 0.3), in spite of it was longer with the group of RV involvement, it did not reach a statistical significance.

We found that the right ventricle was more affected with post PCI TIMI flow II than post PCI TIMI flow III as observed from RV EF, PER and PFR (P: 0.021, 0.018 and 0.006 respectively). We noticed also that the right ventricle was more affected with failure of resolution of ST segment after the primary PCI (P < 0.05). Also, we found that the right ventricle was more affected with failure of occurrence of early peaking of cardiac enzymes (P ≤ 0.001), we did not find similar studies to compare our results with it.

Our results revealed a significant statistical relation between RT ventricular affection and in-hospital complications (P-values are 0.002, 0.003, 0.001 and 0.004). There was a relation between right ventricular affection and the one year mortality but it did not reach the statistically significant value, P ≥ 0.05. This may be explained by the small number of died patients, which may be related to that the mean LV ejection fraction in our study was 40.4% and most of patients

(26 patients) had a smooth course during the study. Shah PK and his colleagues in year 1986 [17] performed a study on 114 consecutive patients with acute myocardial infarction (AMI), radionuclide ventriculography was done to determine the left and right ventricular ejection fractions (EFs). They found that among patients with an acute myocardial infarction, the presence of a low radionuclide right ventricular ejection fraction (<0.38) plus low left ventricular ejection fraction (<0.30) results in 3 times the 1-year mortality of patients with poor left ventricular function alone.

5. Conclusion

The incidence of right ventricular dysfunction in patients with acute left ventricular STEMI is higher than expected and has a negative impact on their outcome.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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