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Echocardiographic Assessment of Right Ventricular Function in Patients with Acute Anterior wall Myocardial Infarction

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ABSTRACT

Background: The main cause of death globally is acute myocardial infarction (AMI), specifically acute coronary syndrome (ACS). In the setting of acute myocardial infarction, right ventricular (RV) infarction has a greater risk of adverse outcomes.

Objective: The goal of this study was to evaluate the right ventricular function in patients with an acute anterior myocardial infarction.

Patients and methods: This case control study included 60 participants who were divided into two groups; group 1 included 30 patients with acute anterior myocardial infarction (first attack and within 1-12 hours of symptoms onset), and group 2 (control group) included 30 age and gender matched group with no MI. All patients with acute anterior MI were managed by primary percutaneous coronary intervention (PCI).

Results: Compared to control group, we found that the mean RIMP was significantly higher in the MI group (0.50 ± 0.081 vs 0.28 ± 0.043, $p < 0.001$), mean TAPSE was significantly lower in the MI group (1.76 ± 0.391 cm vs 2.38 ± 0.420 cm, $p < 0.001$), mean fractional area change was significantly lower in the MI group (32.34 ± 3.625 % vs 48.00 ± 5.350 %, $p < 0.001$), mean DTI-derived tricuspid lateral annular systolic velocity was significantly lower in the MI group (11.091 ± 2.0334 cm/s vs 13.077 ± 3.0285 cm/s, $p= 0.014$), and mean right ventricle strain was significantly lower in the MI group (-16.47 ± 3.246 vs -26.83 ± 2.276, $p < 0.001$).

Conclusion: Echocardiographic RV function parameters are significantly lower in the setting of acute anterior MI compared to controls denoting more RV dysfunction among this group of patients.

Keywords: MI, RVD, TAPSE, RIMP.

INTRODUCTION

The greatest cause of mortality globally is myocardial infarction (MI) [(1)]. RV dysfunction was revealed to be a significant determinant in the prognosis, mortality, and incidence of cardiogenic shock in individuals with acute myocardial infarction [(2)].

Numerous studies have shown the value of several echocardiographic parameters, including tricuspid annular plane systolic excursion (TAPSE), fractional area change (FAC), tissue Doppler imaging of the lateral tricuspid annulus (S′), right ventricular myocardial performance index (RIMP), and more recently RV free wall global longitudinal strain (RV-GLS) for the evaluation of RV systolic function [(3-5)].

Up to 50% of patients with acute inferior/posterior MI and up to 10% of individuals with anterior STEMI had RV dysfunction. The mechanism of left ventricular (LV) dysfunction with anterior wall infarctions and right ventricular (RV) dysfunction with inferior wall infarction are similar [(4-5)].

Nonetheless, there is no study assessing the right ventricular function in anterior myocardial infarction patients. The goal of this study was to evaluate the right ventricular function in patients with an acute anterior myocardial infarction**.**PATIENTS AND METHODS

This case control study included 60 participants who were divided into two groups; group 1 included 30 patients with acute anterior myocardial infarction (first attack and within 1-12 hours of symptoms onset), and group 2 (control group) included 30 age and gender matched group with no MI. All patients with acute anterior MI were managed by primary PCI.

Patients who experienced a left bundle branch block or another type of intraventricular conduction delay, patients with previous history of MI, significant valvular disease, pulmonary hypertension with RV systolic pressure by echocardiography >50 mmHg were excluded from the study.

According to the American Society of Cardiology's recommendations, an echocardiographic evaluation of RV function was carried out within 24 hours after the beginning of symptoms [(6)].

Echocardiographic assessment of RV function:

1. TAPSE (Trans annular plane systolic excursion): By using M-mode in the apical four-chamber image, the total displacement of the lateral mitral annulus (measured in millimetres) was determined [(6)].

2. RV 2D FAC (Fractional area change): Tracing the RV area (including the trabeculae in the RV cavity) was done in systole and diastole in the RV-focused apical four-chamber view. RV FAC (%) = 100 x (EDA-ESA)/EDA [(6)].

3. DTI-Derived Tricuspid Lateral Annular Systolic Velocity (S'): Peak systolic speed of the lateral tricuspid annulus measured by pulsed wave TDI in the apical four chamber view (cm/sec) [(6)].

4. RIMP (Right ventricular myocardial performance index**):** Tricuspid valve closure opening time (TCO),

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which is the amount of time between the tricuspid valve closing (the end of the A wave) and the tricuspid valve opening (the start of the subsequent E wave), was measured in the apical 4-chamber view [6].

The RV outflow tract's pulsed Doppler was recorded. Time from the beginning to the end of the Doppler flow was used to compute the ejection time (ET). MPI was determined by dividing TCO-ET by ET.

5. RV Strain: Using speckle tracking, the global longitudinal strain of the right ventricle was determined in the RV-focused four-chamber image [6].

RV dysfunction was defined as the presence of 2 or more of the following: TAPSE< 17 mm, RV FAC < 35%, S' velocity < 9.5 cm/sec measured on the free-wall side indicates RV systolic dysfunction, RIMP > 0.43 [6].

Ethical approval:

Written consent was taken from every case sharing in the study. All the steps of the test in fullest possible information were explained to any patient who was considered to take part in this research, presented in terms and a form that they could fully understand. The study was approved by the Ethical Committee Council of Suez Canal University. The study was carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Statistical analysis:

The acquired data were statistically analysed using SPSS statistics for Windows (Statistical Package for the Social Sciences), version 26 (IBM, Armonk, NY, USA). Continuous data are summarised as mean and standard deviation (SD), whereas categorical data are provided as absolute values and percentages. Chi-squared tests was employed to compare categorical variables. Student's t-test was used to compare continuous variables. Statistics were considered significant for P values below 0.05.

RESULTS

Regarding the baseline characteristics of the studied groups, no statistically significant difference between the two groups was found regarding age, mean BMI and gender. Where MI group had significantly higher incidence of HTN, DM, and smoking than the control group (table 1).

Table (1): Baseline characteristics of the studied groups

		MI group (n= 30)	Control group (n= 30)	P
Age (years)		60.87 ± 11.676	56.60 ± 9.719	0.129
Smoking		16 (53.3%)	0 (0.0%)	**< 0.001**
BMI (kg/m^2)		29.31 ± 2.892	29.00 ± 3.361	0.706
Gender	**Male**	29 (96.7%)	27 (90.0%)	0.301
	Female	1 (3.3%)	3 (10.0%)	
HTN		9 (30.0%)	0 (0%)	**0.001**
DM		7 (23.3%)	0 (0%)	**0.005**

We found that the mean RIMP in the MI group was significantly higher than in the control group. All studied parameters of RV systolic function were significantly lower in the MI group compared to controls including: Mean TAPSE, mean fractional area changes, mean DTI-derived tricuspid lateral annular systolic velocity, and mean RV free wall strain. RV dysfunction was significantly higher in the MI group compared to controls (Table 2).

Table (2): Echocardiographic assessment of right ventricle in the studied groups

	MI group (n= 30)	Control group (n= 30)	P
RIMP	0.50 ± 0.081	0.28 ± 0.043	**< 0.001**
TAPSE (cm)	1.76 ± 0.391	2.38 ± 0.420	**< 0.001**
Fractional area change (%)	32.34 ± 3.625	48.00 ± 5.350	**< 0.001**
DTI-Derived tricuspid Lateral Annular Systolic Velocity (cm/s)	11.091 ± 2.0334	13.077 ± 3.0285	**0.004**
Right ventricle Strain	-16.47 ± 3.246	-26.83 ± 2.276	**< 0.001**
Right ventricular dysfunction	4 (13.3%)	0 (0%)	**0.038**

RIMP: Right Ventricular Index of Myocardial Performance, **TAPSE:** Tricuspid annular plane systolic excursion, **DTI:** Doppler tissue imaging.

Among the anterior MI group, RV dysfunction was found more by RIMP followed by RV free wall strain (Table 3).

Table (3): RV dysfunction by different echocardiographic methods

	MI group (n= 30)	Control group (n= 30)	P
RIMP	28 (93.3%)	1 (3.3%)	**< 0.001**
TAPSE (cm)	15 (50.0%)	1 (3.3%)	**< 0.001**
FAC	4 (13.3%)	0 (0%)	**0.038**
DTI-Derived tricuspid Lateral Annular Systolic Velocity	3 (10.0%)	3 (10.0%)	**1**
Right ventricle Strain	13 (43.3%)	0 (0.0%)	**< 0.001**

DISCUSSION

This study exclusively included patients with anterior MI and found that 4 of 30 patients with anterior MI (13.3%) had RV dysfunction. Two patients with right ventricular dysfunction had anteroseptal MI, one patient had anterolateral MI, and one patient had extensive anterior MI.

Keskin *et al.* [7] study also found that 45 of 350 patients (12.9%) with anterior MI developed RV dysfunction. Also, **Karakurt and Akdemir**[8] found abnormal RV myocardial performance index in primary PCI that was performed in 22% of patients who presented with anterior STEMI.

Some investigations assessed RV function following MI in the absence of clinical or ECG signs of RV infarction. In 47% of patients with acute inferior wall MI and 65% of patients with acute anterior STEMI, **Jensen *et al.*** [9] discovered RV dysfunction. According to **Masci *et al.*** [10] only one-third to one-half of individuals have post-MI RV ischemia damage without clinical signs of hemodynamic RV impairment. By using MRI, RV dysfunction in this situation can be shown as late gadolinium elevation and myocardial edema. RV damage is frequently observed in anterior infarcts as well, not just inferior infarcts. According to **Kidawa *et al.*** [11] findings, 64% of their patients had RV dysfunction as determined by TAPSE. The fact that they included all STEMI patients with the potential for RV infarction in addition to the various evaluation factors may account for the greater incidence.

RV branches from the LAD and the conus branch of the RCA both send blood to the anterior part of the RV. Therefore, the RCA should ensure that the right ventricle receives blood supply in the case of anterior wall infarctions (with LAD obstruction), but our work, in line with **El-Sayed Hammad *et al.*** [12]**,** discovered that RV dysfunction might arise in anterior MI.

However, **Keskin *et al.*** [7] reported that TAPSE and RV S′ velocity were significantly correlated with FAC and may provide quick and accurate measurements of RV systolic function in acute MI patients. Many studies suggested that FAC could be a reliable marker of RV dysfunction with prognostic implications.

We agree with **Hsu *et al.*** [13] that our RIMP results were statistically substantially higher in anterior MI patients, which may be because these patients had bigger infarctions that had greater total CK.

El-Sayed Hammad *et al.* [12] did not find that the underlying confounding patient-related factors affected their findings because there was no statistically significant difference between the impaired and normal RV function groups in terms of age, gender, DM, HTN, smoking, family history, and dyslipidemia. The same point was made by **Hsu *et al.*** [13] who also claimed that there was no connection between advancing years and RV dysfunction.

This may be explained by the fact that our research sample consisted of patients with a mean age of 60.87±11.676 years as opposed to 59±12 years in the study by **Hsu *et al.*** [13]**,** making the influence of age was similar to our population when comparing both groups' normal and pathological RV performance. The prevalence of DM in their community was comparable to the prevalence in our patients (28.5% vs. 23.3%), hence **Hsu *et al.*** [13] did not find a link between DM and RVD.

In contrast to other research, **Abdeltawab *et al.*** [14] attributed this to patients who were on average 45.9±7.6 years younger, which is why when comparing both groups' normal and poor RV performance, the influence of age becomes apparent in comparison with their population. Regarding sex or DM, HTN, or hyperlipidemia, there was no statistically significant difference between the groups.

The limited research population prevents generalisation of our findings, which is one of our study's limitations. Also, we only studied the acute stage of MI and RV functional recovery may occur later on after acute MI, so later assessment of RV function could result in different findings. We didn't follow-up patients after discharge to assess improvement of RV function with time and the long-term effects of our findings.

CONCLUSION

The incidence of RV dysfunction in anterior MI patients was 13.3%. RIMP and DTI-derived tricuspid lateral annular systolic velocity were the significant predictors of RVD in patients with acute anterior myocardial infarction. RIMP was significantly positively correlated with occurrence of MI while right ventricle strain, TAPSE, fractional area change, and DTI-derived tricuspid lateral annular systolic velocity were significantly negatively correlated with occurrence of MI.

Echocardiography is reliable for RV systolic function assessment (especially RV free wall strain and RIMP) and may add prognostic data in patients with acute anterior MI. So, assessment of RV systolic function in anterior STEMI should be more tedious and thorough.

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