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The Effect of Elective Percutaneous Coronary Intervention of the Right Coronary Artery on Right Ventricular Function

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ABSTRACT

Background: Right Ventricular (RV) dysfunction has been introduced as a predictor of mortality in acute myocardial infarction.

Objectives: This study aimed to investigate the effect of right coronary revascularization on systolic and diastolic RV dysfunction.

Patients and Methods: This study was conducted on unstable angina patients who were candidate for elective Percutaneous Revascularization Intervention (PCI) on the right coronary artery. The participants were initially evaluated by transthoracic echocardiography and tissue Doppler imaging prior to PCI and the RV function parameters were assessed. Echocardiography was repeated two months after PCI and the results were compared with baseline. Paired t-test was used to compare the pre- and post-procedural measurements. Besides, Pearson's correlation was used to find out the linear association between the RV function parameters and Left Ventricular Ejection Fraction (LVEF). P value < 0.05 was considered as statistically significant.

Results: This study was conducted on 30 patients (mean age = 60.00 ± 8.44 years; 24 [80%] males). In the pre-procedural echocardiography, 15 patients (50%) had normal RV function, 14 patients (46.7%) had grade-1 RV dysfunction, and only 1 patient (3.3%) had grade-2 RV dysfunction. Following PCI, however, all the patients had normal systolic and diastolic RV functions. Comparison of echocardiographic RV function parameters showed an improvement in both systolic and diastolic functional parameters of the RV. Nonetheless, no significant correlation was observed between these parameters and Left Ventricular (LV) function.

Conclusions: A significant improvement was found in RV function, but not LV function, after right coronary PCI. Revascularization of the right coronary artery may be beneficial for the patients who suffer from RV failure due to ischemia.

►*Implication for health policy/practice/research/medical education:*
In this study, we observed a significant improvement in the right ventricular function, both systolic and diastolic, after right coronary artery angioplasty. Conversely, there was no correlation between the right ventricular function parameters and LVEF in this study. Revascularization of the right coronary artery may be beneficial for the patients suffering from right ventricular failure.

1. Background

By the advent of Percutaneous Coronary Interventions (PCI) and its improvements, the rate of short-term and long-term mortality following Acute Myocardial Infarction (AMI) has decreased substantially (1). However, several factors intervene in prediction of AMI patients' mortality and morbidity. Also, coronary occlusion during PCI could create transient myocardial ischemia, thereby reducing the systolic strain in both longitudinal and radial directions (2).

Right Ventricular (RV) dysfunction has been introduced as a good predictor for mortality in AMI patients (3-5). Moreover, Right Coronary Artery (RCA) occlusion proximal

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to the major blood supplying RV branches was accompanied by severe RV dysfunction (6). Although numerous studies have investigated the role of Left Ventricular (LV) function in the prognosis of AMI patients, data about systolic and diastolic RV function is still insufficient. This can be due to technical difficulties of echocardiographic evaluation of RV or underestimation of the cardiologists (7). RV function can be affected discrepantly by the infarction site in AMI patients (8). Therefore, the location of ischemia can play a major role in development of RV dysfunction. However, the current data is inconclusive and sparse.

2. Objectives

Hence, the present study aims to investigate the effect of right coronary PCI on systolic and diastolic RV function. It also seeks to determine the association between RV dysfunction and LV function and other cardiovascular parameters, such as hypertension.

3. Patients and Methods

This before-after study was performed at Shariati General Hospital affiliated to Tehran University of Medical Sciences, Tehran, Iran. The study population consisted of unstable angina patients who were candidate for elective PCI in our center between February 2012 and February 2013. The inclusion criteria of the study were age between 40 and 75 years for both genders, PCI of the RCA, no history of coronary obstructive pulmonary disease or any other chronic respiratory conditions, no history of coronary artery bypass grafting or valvular surgery, presence of persistent sinus rhythm, no history of renal or hepatic failure, no history of cardiomyopathy, and successful PCI.

Written informed consents were obtained from all the study patients before recruitment and the study proposal was approved by the Research Board and Ethics Committee of Tehran University of Medical Sciences.

Prior to the PCI procedure, the participants were evaluated by transthoracic echocardiography and tissue Doppler imaging using GE Vivid 7 Dimensions ultrasound system (GE Healthcare, Milwaukee, WI). RV and LV sizes were defined as the size of the ventricular cavity areas at end-diastole and end-systole for each ventricle. Besides, RV and LV functions were assessed as the percent of change in the ventricular cavity area from end-diastole to end-systole. Left Ventricular Ejection Fraction (LVEF) was evaluated by eyeball estimation. The reference limits of all the echocardiographic parameters were defined according to the American Society of Echocardiography Guidelines (9). RV function was assessed using the following measurements:

1) Right Ventricular Fractional Area Change (RVFAC) calculated through the following formula: (end-diastolic area × end-systolic area)/end diastolic area (10), 2) Tricuspid Annular Plan Systolic Excursion (TAPSE) measured using M-mode in the RV free wall, 3) Tissue Doppler imaging study and assessing the tricuspid annulus for calculating A` and E` and thereby RV diastolic dysfunction.

All the echocardiography procedures were repeated 2 months after the procedure and the results were compared to baseline.

It should be noted that all the echocardiographic evaluations were performed by a cardiologist who was blinded to the study protocol.

3.1. Statistical Analysis

Continuous variables were shown as mean ± Standard Deviation (SD), while the categorical ones were described as number (percentage). Normal distribution of the continuous variables was tested by Kolmogorov–Smirnov test. Then, paired t-test was used to compare the pre- and post-procedural measurements. In addition, Pearson's correlation was employed to assess the linear association between RV function parameters and LVEF. P values < 0.05 were considered as statistically significant. All the statistical analyses were performed using the SPSS statistical software, version 15 (SPSS Inc., Chicago, Illinois, USA).

4. Results

Out of the 148 candidates for elective PCI, 30 patients (mean age = 60.00 ± 8.44 years; 24 [80%] males) met the study criteria and were enrolled into the study. All the patients underwent successful PCI and no serious periprocedural complication was reported. Demographic characteristics of the study population have been presented in Table 1.

Table 1. Baseline Characteristics of the Study Population

Characteristic	Study Population (n = 30)
Age, years	60.00 ± 8.44
Male gender, n (%)	24 (80)
Height, cm	169.53 ± 7.58
Weight, kg	75.06 ± 6.48
BMI, kg/m^2	26.28 ± 4.52
Hypertension, n (%)	20 (66.6)
Diabetes mellitus, n (%)	14 (46.7)
Dyslipidemia, n (%)	19 (63.3)
Smoking, n (%)	14 (46.7)
Use of β-blocker, n (%)	8 (26.7)
Use of ACE-inhibitor, n (%)	22 (73.3)
Use of statin, n (%)	17 (56.7)
Use of Aspirin, n (%)	9 (30)
Inferior MI, n (%)	15 (50)

Abbreviations: ACE, Angiotensin-converting enzyme; BMI, Body mass index; MI, Myocardial infarction

In pre-procedural echocardiography, 15 patients (50%) had normal RV function, 14 patients (46.7%) had grade-1 RV dysfunction, and only 1 patient (3.3%) had grade-2 RV dysfunction. Based on the FAC, 1 patient had diastolic RV dysfunction. Based on TAPSE, however, all the patients had normal diastolic RV function. On the other hand, systolic RV dysfunction was observed in 4 patients (13.3%) based on Right Ventricular peak Systolic Velocity (RVSM) and the rest had normal systolic RV function.

In post-procedural PCI, all the patients had normal systolic and diastolic RV function as defined by FAC, TAPSE, and RVSM. However, Myocardial Performance Index (MPI) measurements showed that 3 patients (10%) had systolic dysfunction. The results revealed a significant change in MPI following the procedure ($P < 0.001$). Furthermore, comparison of the echocardiographic RV function parameters showed an improvement in both systolic and diastolic functional parameters of the RV (Table 2). Nonetheless, no significant correlation was observed between these parameters and LV function (Table 3).

5. Discussion

The findings of the current study demonstrated a significant improvement in both systolic and diastolic functions of RV following PCI of the RCA. However, this improvement was independent from the LV function as defined by LVEF.

The location of coronary artery involvement can influence RV function (8). It was reported in the same study that in the patients with inferior infarction and without associated RV infarction, most echocardiographic indicators of RV function, except for RV diastolic function, resembled those in healthy subjects. Conversely, global RV function changed more significantly in the patients with anterior wall infarction. Moreover, it has been shown that RV ejection fraction decreased significantly in the patients with proximal RCA involvement compared to those who had lesions in the left ascending artery or distal RCA (11). Thus, one can conclude that RV dysfunction was present in the patients with proximal RCA involvement. Additionally, RVFAC, TAPSE, and RV strain were strong predictors of the composite end point all-cause mortality, reinfection, and hospitalization for heart failure in the patients who underwent primary PCI following AMI (12).

In the present study, we comprehensively studied RV function using RVFAC, TAPSE, and MPI before and after the PCI. Comparison of the measurements showed rapid correction of RV function, which is in line with the previous studies indicating that RV function was recovered partially after AMI (13). This also implies the importance of revascularization of the affected arteries, despite the fact that we studied the candidates of elective PCI due to single vessel disease and not the primary PCI patients.

In the previous studies, TAPSE was significantly associated with LVEF (13, 14). Nevertheless, the present study results revealed no correlation between RV function indices, including TAPSE, and LV function. Moreover, the changes of TAPSE following PCI were not significant, which may explain that TAPSE is not an independent parameter.

This study could provide basic evidence for the changes in RV function following the PCI of the RCA. Yet, it had some limitations that are needed to be mentioned. The small sample size was an important shortcoming of the current study. It should be noted that a limited number of patients met the inclusion criteria and were enrolled into the study. Besides, this was a single center study and, consequently, our results cannot be generalized unless they are reconfirmed in larger multi-center studies. Additionally, we just included single-vessel coronary disease patients with involvement of the RCA. It is plausible that the pattern of changes in RV function might be different in the patients with more vessels involvement. Finally, we did not study the type, size, and length of the used stents and the anatomical features of the stenotic artery. These factors could have affected the cardiac function either before or after the procedure.

To sum up, the study findings showed a significant improvement in RV function, both systolic and diastolic, after the right coronary angioplasty. Conversely, no correlation was found between the RV function parameters and LVEF in this study. Due to our limitations and sparse data on improvement of RV function following PCI, further studies with larger sample sizes and considering the stenosis of other branches of the coronary arteries are recommended

Table 2. Comparison of the Echocardiographic Features of the Right Ventricle before and after PCI

Index	Before	After	P value
E/A	1.46 ± 2.02	1.10 ± 0.24	0.332
DT	145.26 ± 13.64	152.43 ± 12.34	< 0.001
E/E`	2.56 ± 1.05	2.50 ± 0.70	0.686
FAC%	51.16 ± 8.0	54.05 ± 7.49	< 0.001
RVSM	10.86 ± 1.27	11.80 ± 1.03	< 0.001
TAPSE	21.36 ± 1.71	21.73 ± 1.94	0.317
MPI	0.31 ± 0.05	0.33 ± 0.04	< 0.001

Abbreviations: TAPSE, Tricuspid annular plane systolic excursion

Table 3. The Correlation between Right Ventricular Function Parameters and Left Ventricular Ejection Fraction

Characteristic	Pearson's Correlation	P value
RVFAC	0.3	0.839
MPI	0.25	0.162
TAPSE	0.29	0.110

Abbreviations: RVFAC, Right ventricular fractional area change; TAPSE, Tricuspid annular plane systolic excursion

to be conducted on the issue.

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Authors' Contribution

Study concept and design: Farahnaz Nikdoust, Seyed Abdolhosein Tabatabaei, Atoosa Mostafavi; Acquisition of data: Farahnaz Nikdoust, Sareh Mohammadi; Analysis and interpretation of data: Maryam Mohamadi, Sareh Mohammadi, Akbar Shafiee; Drafting of the manuscript: Akbar Shafiee; Critical revision of the manuscript for important intellectual content: Sareh Mohammadi, Akbar Shafiee; Statistical analysis: Maryam Mohamadi, Sareh Mohammadi; Administrative, technical, and material support: Seyed Abdolhosein Tabatabaei, Atoosa Mostafavi; Study supervision: Farahnaz Nikdoust, Seyed Abdolhosein Tabatabaei, Atoosa Mostafavi

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References

1. Hochman JS, Sleeper LA, Webb JG, Sanborn TA, White HD, Talley JD*, et al*. Early revascularization in acute myocardial infarction complicated by cardiogenic shock. SHOCK Investigators. Should We Emergently Revascularize Occluded Coronaries for Cardiogenic Shock. *N Engl J Med*. 1999;**341**(9):625-34.
2. Kukulski T, Jamal F, Herbots L, D'Hooge J, Bijnens B, Hatle L*, et al*. Identification of acutely ischemic myocardium using ultrasonic strain measurements. A clinical study in patients undergoing coronary angioplasty. *J Am Coll Cardiol*. 2003;**41**(5):810-9.
3. Engstrom AE, Vis MM, Bouma BJ, van den Brink RB, Baan J, Jr., Claessen BE*, et al*. Right ventricular dysfunction is an independent predictor for mortality in ST-elevation myocardial infarction patients presenting with cardiogenic shock on admission. *Eur J Heart Fail*. 2010;**12**(3):276-82.
4. Mehta SR, Eikelboom JW, Natarajan MK, Diaz R, Yi C, Gibbons RJ*, et al*. Impact of right ventricular involvement on mortality and morbidity in patients with inferior myocardial infarction. *J Am Coll Cardiol*. 2001;**37**(1):37-43.
5. Zornoff LA, Skali H, Pfeffer MA, St John Sutton M, Rouleau JL, Lamas GA*, et al*. Right ventricular dysfunction and risk of heart failure and mortality after myocardial infarction. *J Am Coll Cardiol*. 2002;**39**(9):1450-5.
6. Bowers TR, O'Neill WW, Grines C, Pica MC, Safian RD, Goldstein JA. Effect of reperfusion on biventricular function and survival after right ventricular infarction. *N Engl J Med*. 1998;**338**(14):933-40.
7. Shah AR, Grodman R, Salazar MF, Rehman NU, Coppola J, Braff R. Assessment of acute right ventricular dysfunction induced by right coronary artery occlusion using echocardiographic atrioventricular plane displacement. *Echocardiography*. 2000;**17**(6 Pt 1):513-9.
8. Hsu SY, Lin JF, Chang SH. Right ventricular function in patients with different infarction sites after a first acute myocardial infarction. *Am J Med Sci*. 2011;**342**(6):474-9.
9. Lang RM, Bierig M, Devereux RB, Flachskampf FA, Foster E, Pellikka PA*, et al*. Recommendations for chamber quantification: a report from the American Society of Echocardiography's Guidelines and Standards Committee and the Chamber Quantification Writing Group, developed in conjunction with the European Association of Echocardiography, a branch of the European Society of Cardiology. *Journal of the American Society of Echocardiography : official publication of the American Society of Echocardiography*. [Practice Guideline]. 2005;**18**(12):1440-63.
10. Kaul S, Tei C, Hopkins JM, Shah PM. Assessment of right ventricular function using two-dimensional echocardiography. *Am Heart J*. 1984;**107**(3):526-31.
11. Shinomiya H, Fukuda N, Takeichi N, Soeki T, Shinohara H, Yui Y*, et al*. Echocardiographic assessment of right atrial function in patients with myocardial infarction with reference to obstructive lesions of the coronary arteries. *Jpn Circ J*. 1998;**62**(6):393-8.
12. Zehender M, Kasper W, Kauder E, Schonthaler M, Geibel A, Olschewski M*, et al*. Right ventricular infarction as an independent predictor of prognosis after acute inferior myocardial infarction. *N Engl J Med*. 1993;**328**(14):981-8.
13. Popescu BA, Antonini-Canterin F, Temporelli PL, Giannuzzi P, Bosimini E, Gentile F*, et al*. Right ventricular functional recovery after acute myocardial infarction: relation with left ventricular function and interventricular septum motion. GISSI-3 echo substudy. *Heart*. 2005;**91**(4):484-8.
14. Samad BA, Alam M, Jensen-Urstad K. Prognostic impact of right ventricular involvement as assessed by tricuspid annular motion in patients with acute myocardial infarction. *Am J Cardiol*. 2002;**90**(7):778-81.