The Correlation Between Right Ventricular Function and Dominance of Right Coronary Artery

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ABSTRACT

Introduction: The right heart is more unknown than the left heart, because of less research. With it, its importance is understood, when right heart related diseases are considered. The relation between coronary vascularity and cardiac function is indisputable. There are no research about the effect of coronary dominance, that is anatomical variation merely, upon cardiac function. We investigated difference of right or left domination on right ventricle functions using echocardiography.

Patients and Methods: Working group was contained patients who is done coronary angiography with any indication. Patients were categorized right dominant and non-dominant on coronary angiography. At the same time, the origin of posterior descending artery was determined. There were 2 groups and each of them had 40 patients. Patients who had >50% stenosis on coronary arteries, myocardial infarct previously, cardiac valve disease, chronic obstructive lung disease and pulmoner embolism in past were excluded. Right ventricle functions were investigated using Echocardiography by the same operator. The results were evaluated and calculated average value by two different operators. We used Wilcoxon and Mann-Whitney U Test in evaluation of statistics.

Results: There was no difference between groups in terms of the right ventricular functions; TAPSE (26.47 ± 3.39 vs 25.31 ± 5.19 p= 0.096), FAC (43.19 ± 9.18 vs 47.5 ± 10.7 p= 0.720), GLS by STE (20.55 ± 4.033 vs 19.73 ± 4.71 p= 0.451), RIMP (53.84 ± 11.2 vs 52.93 ± 9.01 p= 0.947).

Conclusion: The effect of right coronary artery dominance on right ventricle functions was not obtained significant.

Key Words: RIMP; coronary dominance; FAC; GLS; STE; TAPSE

Sağ Koroner Arter Baskınlığı ile Sağ Ventrikül Fonksiyonlarının Korelasyonu

ÖZET

Giriş: Sağ kalp sol kalbe göre üzerine daha az çalışma yapılması nedeniyle daha bilinmezlerle dolu olmasına rağmen sağ kalp tutulumlu hastalıklar göz önünde bulundurulduğunda önemi daha net anlaşılmaktadır. Koroner vaskülaritenin kardiyak fonksiyonlar üzerine su götürmez ilişkisi vardır. Sadece anatomik bir varyasyon olan koroner arter baskınlığının kardiyak fonksiyon üzerine etkisi üzerine daha önce yapılmış bir çalışma bulunmamaktadır. Biz bu çalışmada sağ baskın sistemle sağ baskın olmayan (sol baskın) sistemin sağ ventrikül fonksiyonları üzerine farklılık gösterip göstermediğini ekokardiyografik olarak araştırdık.

Hastalar ve Yöntem: Kliniğimizde herhangi bir endikasyon ile koroner anjiografisi yapılan hastalar çalışma grubunu oluşturdu. Hastalar koroner anjiografi esnasında sağ baskın ve sağ baskın olmayan olarak sınıflandırıldı. Bu ayrımda PDA'nın hangi damardan kök aldığına bakıldı. Her iki gruba 40'ar hasta alındı. Koroner arterlerinde >%50 darlık olan hastalar, daha önceden geçirilmiş miyokard infarktüsü öyküsü olan, kalp fonksiyonları üzerine etkisi olabilecek kapak patolojisi, yine sağ kalp üzerine etkisi olan kronik obstriktif akciğer hastalığı (KOAH), geçirilmiş pulmoner emboli gibi hastalık öyküsü olanlar çalışmaya alınmadı. Tüm hastalara ekokardiyografi ile sağ ventrikül fonksiyonları açısından inceleme yapıldı. Görüntüler kayıtları aynı operatör tarafından alındı. Alınan kayıtlar iki farklı operatör tarafından ayrı ayrı ölçümleri alınarak ortalama değeri hesaplandı. İstatistiki değerlendirme Wilcoxon ve Mann-Whitney U testi kullanılarak yapıldı.

Bulgular: İki grupta sağ ventrikül fonksiyonlarını değerlendiren parametreler sırasıyla SVMPI (53.84 ± 11.2'e karşı 52.93 ± 9.01 p= 0.947), FAD (43.19 ± 9.18'e karşı 47.5 ± 10.7 p= 0.720), GLS (20.55 ± 4.033'e karşı 19.73 ± 4.71 p= 0.451), serbest duvar straini (20.78 ± 4.54'e karşı 19.78 ± 4.71 p= 0.291) TAPSE (26.47 ± 3.39'a karşı 25.31 ± 5.19 p= 0.096) şeklinde bulundu.

Sonuç: Bu çalışmada izole olarak sağ koroner arter baskınlığının sağ ventrikül fonksiyonları üzerine anlamlı bir etkisinin olmadığı anlaşılmıştır.

Anahtar Kelimeler: Dominans; koroner damarlar; sağ ventriküler fonksiyon

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INTRODUCTION

The right ventricle (RV) is considered the neglected heart chamber due to inadequate research. It is speculated that the anatomy of the RV makes it less vulnerable to myocardial ischemia and protects it from being affected by myocardial and valvular diseases. Recent data suggested that several cardiac conditions have devastating effects on the function of the RV and this dysfunction has a severe prognostic impact. In practice, RV functions including abnormal filling and contraction may deteriorate in the absence of RV heart failure. Prior studies evaluating the RV were mainly focused on diseases that were known to affect RV functions including inferior myocardial infarction with RV involvement, chronic obstructive pulmonary disease (COPD), pulmonary hypertension (PH), and pulmonary hypertension secondary to chronic pulmonary thromboembolism (CTEPH).

There is solid evidence between impairment in coronary blood flow and myocardial functions. Ischemic cardiomyopathies are mainly caused by stenosis in coronary arteries leading to reversible or irreversible myocardial ischemia. In the present study, we aimed to compare the effect of right coronary artery (RCA) dominancy on RV functions in patients who do not have any diseases causing dysfunction in the RV such as coronary stenosis, COPD, PH, CTEPH, or valvular heart diseases.

PATIENTS and METHODS

Between December 2016 and May 2017, patients who underwent coronary angiography (CAG) and were found to have <50% stenosis in any coronary artery were divided into two groups according to the right coronary artery dominancy which was determined by the origin of the posterior descending artery (PDA)[1]. It was considered right or non-right coronary artery-dominant based on whether PDA originated from the RCA or not, respectively. Overall, 80 patients were included, and each group consisted of 40 patients.

The inclusion criteria were the following:

1) Undergoing CAG for the indications that were recommended in the latest guidelines,

2) Left ventricular ejection fraction (LVEF)> 50%,

3) Sinus rhythm in the baseline electrocardiography recording,

4) Absence of >50% stenosis in any coronary artery, and

5) Age between 18-80.

The exclusion criteria included the following:

1) Severe valvular heart disease,

2) Prior cardiac surgery,

3) Condition that may cause dysfunction in the RV including COPD, PH, and CTEPH,

4) Atrial fibrillation and

5) Prior myocardial infarction.

Patients underwent detailed physical examination and were probed for their medical histories.

Echocardiography

The study population underwent echocardiographic evaluation by an experienced cardiac imager with an EPIQ 7C (EPIQ Evolution 2.0) echocardiography device. All cardiac chamber quantifications were determined according to the latest guidelines[2]. RV basal, mid and apical diameters were measured at the end diastole in four chambers in the apical position. In the same window, systolic diameters were measured to calculate fractional area change (FAC). Tricuspid annular plane systolic excursion (TAPSE), isovolumetric relaxation time (IVRT), isovolumetric contraction time (IVCT), and ejection time (ET) were determined in accordance with the recent guidelines. Right ventricular myocardial perfusion index (RVMPI) was calculated as (IRT+ICT)/ET x 100.

RV global and free wall strains were obtained through apical four-chamber view and simultaneous ECG recording. RV Strain measurements were calculated with the modification of the left ventricular strain software as there is none for RV in our institution.

Statistical Analysis

Continuous variables were given as mean ± standard deviation, categorical variables were given as percentages. Intergroup differences were calculated by using Mann-Whitney U testing. P values of less than 0.05 were deemed statistically significant. All statistical analyses were made using SPSS for Windows, version 20.0, (SPSS Inc, Chicago, Illinois, USA).

RESULTS

Overall 134 patients were included in the study. Fourteen patients were excluded from the study because of COPD, 23 patients with previous CAD, 13 patients with AF, and four patients due to idiopathic CMP. Among those 40 patients had right dominancy and 40 had non-right dominancy. The mean age of patients were 51.56 ± 10.28 and 56.46 ± 9.73 in the right dominant and non-right dominant groups, respectively (p= 0.084). Baseline demographic characteristics of the patients are presented in Table 1. There were no significant differences among groups regarding hypertension (p= 0.862) and hyperlipidemia (p= 0.454) but there were more patients with diabetes in the non-right dominant group (p= 0.048).

Table 1. The basal demographic characteristics of study participants

	Dominant Group	Non-dominant Group	p
Age	51.56 ± 10.28	56.46 ± 9.73	0.084
Gender, (M/F)	27/13	21/19	0.440
DM %	25	75	0.048
HT %	40	45	0.862
HL%	50	60	0.454
Cre	1.04	1.09	0.763

DM: Diabetes mellitus, HT: Hypertension, HL: Hyperlipidemia.

Table 2. Table of right ventricle echocardiographic values

	Dominant Group	Non-dominant Group	p
Global longitudinal strain	20.55 ± 4.03	19.73 ± 4.86	0.451
Free wall strain	20.78 ± 4.54	19.78 ± 4.71	0.291
TAPSE	26.47 ± 3.39	25.31 ± 5.19	0.096
RVMPI	53.84 ± 11.2	52.93 ± 9.01	0.947
IVCT	62.48 ± 13.6	55.34 ± 15.4	0.242
IVRT	62.44 ± 13.7	65.76 ± 11.4	0.313
ET	242.28 ± 33.9	237.11 ± 33.2	0.163
RV baseline diameter	3.18 ± 0.50	3.28 ± 0.58	0.644
RV medium diameter	2.50 ± 0.59	2.57 ± 0.50	0.865
RV long diameter	6.60 ± 0.97	6.52 ± 0.73	0.836
RVOT 1	3.19 ± 0.35	3.22 ± 0.31	0.386
RVOT 2	2.96 ± 0.26	2.84 ± 0.41	0.462
TDIs	13.49 ± 2.76	15.13 ± 3.39	0.093
PA diameter	19.91 ± 2.02	20.26 ± 4.04	0.992
P VTI	17.83 ± 3.48	18.12 ± 2.84	0.644
RV ESA	7.88 ± 2.49	7.75 ± 2.69	0.572
RV EDA	14.37 ± 2.97	14.76 ± 3.84	0.910
FAC	46.19 ± 9.18	47.50 ± 10.70	0.720

TAPSE: Tricuspid annular plane systolic excursion, RVMPI: Right ventricular myocardial perfusion index, IVCT: Isovolumetric contraction time, IVRT: isovolumetric relaxation time, ET: Ejection time, RVOT: Right ventricle outlet track, TDIs: Tissue Doppler Imaging S, PA diameter: Pulmonary artery diameter, P VTI: Pulmonary valve velocity time index, RV ESA: Right ventricle end-systolic area, RV EDA: Right ventricle end-diastolic area, FAC: Functional area change.

There was no significant difference in global (20.55 ± 4.03 vs 19.73 ± 4.86, p= 0.451) and free wall (20.78 ± 4.54 vs 19.78 ± 4.71, p= 0.291) strain measurements between groups. Furthermore, there was no difference between groups in terms of TAPSE measurements (26.47 ± 3.39 vs 25.31 ± 5.19, p= 0.096).

Both groups were similar in terms of RVMPI (53.84 ± 11.2 vs 52.93 ± 9.0, p= 0.947), ET (242.28 ± 33.9 vs 237.11 ± 33.2, p= 0.163), IRT (62.44 ± 13.7 vs 65.76 ± 11.4, p= 0.313) and ICT (62.48 ± 13.6 vs 55.34 ± 15.4, p= 0.242).

No differences were found in RV inlet and outlet diameters. The mean end-diastolic and end-systolic areas were 14.37 ± 2.97 vs 14.76 ± 3.84 and 7.88 ± 2.49 vs 7.75 ± 2.69 in the right dominant and non-right dominant groups respectively. Therefore, there was no significant difference in FAD values between groups (46.19 ± 9.18 vs 47.5 ± 10.7, p= 0.720).

We performed S wave velocity with tissue Doppler. In the right-dominant group, TDI was 13.49 ± 2.76, while in the non-right-dominant group it was 15.13 ± 3.39 (p= 0.093). No

significant difference was found in pulmonary artery diameter, and pulmonary valve velocity time index (VTI).

DISCUSSION

In the present study, we found no difference in RV systolic/diastolic functions, diameters, and strain parameters between patients who had right dominant or non-right dominant coronary vasculature. This is the first manuscript that evaluated the effect of coronary dominancy in RV functions in patients who had no disease that may cause RV dysfunction.

Previous studies mainly focused on the RV function in the context of diseases that involved RV such as RV myocardial infarction and PH. In the current manuscript, we evaluated only RCA dominancy on RV functions evaluated by echocardiography in the absence of any significant conditions affecting RV.

In a prior study, Blanchard DG, et al. included patients with CTEPH and compared the Tei index with those without CTEPH. They found higher Tei index those with CTEPH 0.27 ± 0.09 vs 0.52 ± 0.19, p= 0.0001)[3]. When patients underwent pulmonary endarterectomy surgery, there was a significant reduction in Tei index (0.52 ± 0.19 vs 0.33 ± 0.10 (p< 0.0001). In previous studies, an increase in RVMPI was attributed to the conditions that caused an increase in the RV afterload and pulmonary vascular resistance[4,5]. Accordingly, a prior study in which the Tei index was evaluated before and after the revascularization on days zero, seven and 30 revealed that RVMPI was correlated with ischemia severity and RV dysfunction[6]. In this regard, no difference in RVMPI between the right-dominant and non-right-dominant groups was found in our study because we found no difference in pulmonary artery pressure, RV myocardial perfusion abnormality, and RV afterload.

We found no difference in terms of RV inlet and outlet diameters between groups. This finding is consistent with a prior study in which they included patients with myocardial infarction and RV involvement. In this study, Ramzy et al. compared RV planar diameters in patients with inferior myocardial infarction following thrombolytic therapy at discharge and day 30. They found that the RV inlet (4.0 ± 0.7 vs 3.7 ± 0.6 (p= 0.2) and outlet diameters (3.1 ± 0.3 vs 3.3 ± 0.6 (p= 0.2) were statistically similar between groups[6]. Thus, right coronary artery dominancy was not expected to alter RV diameters as no difference was noted even in those with myocardial infarction.

Lemarie et al. investigated patients with anterior and inferior myocardial infarction and compared RV functions with cardiac magnetic resonance imaging (CMRI). Patients with RV EF <50% were considered to have RV involvement and these patients further underwent echocardiographic examination[7,8]. They found that FAD (35.7 ± 11.0 vs 45.3 ± 8.7, p< 0.0001) and RV global strain determined by speckle tracking (17.1 ± 5.2 vs 21.0 ± 3.4, p< 0.0001). Segmental strain analysis revealed that all segments other than the septal segment were significantly correlated. There was no difference other than strain and FAD measurement which was consistent with our findings. This can be attributed to the absence of coronary lesions that can cause ventricular performance.

In CTEPH patients, a previous study investigated the correlation between right heart catheterization with TAPSE and RV longitudinal strain parameters. There was a significant correlation between TAPSE and RV longitudinal strain parameters. In addition, a trend toward a significant correlation was found between TAPSE with mean pulmonary artery pressure, pulmonary vascular resistance, right cardiac output, and cardiac index which did not reach statistical significance[9]. In other studies of pulmonary arterial hypertension patients, deteriorated RV functions were observed despite normal TAPSE values[10]. On the other hand, RV performance might be preserved even in patients with reduced TAPSE, as seen in patients undergoing cardiac surgery[11,12]. In our study, we expected similar TAPSE as there was no underlying condition affecting RV cardiac index and output alteration.

Chang et al. included patients in which exercise intolerance was defined as effort capacity <8 MET and compared RV functions among those with exercise intolerance and those without. They found no significant difference except RV free wall strain measurements as consistent with our findings[13].

Apart from those studies, He, et al. followed 6255 patients who had acute coronary syndrome and underwent CAG for two years. Importantly, patients with left dominant coronary vasculature had a higher risk of mortality and intraaortic balloon pump requirement (2.58% vs 1.23%, p= 0.024)[14]. Left ventricular coronary flow occurs mainly in the diastolic phase of the cardiac cycle. On the other hand, coronary flow to the thin-walled RV occurs both in the diastole and systole. We speculate that in the absence of any condition causing increased RCA vascular resistance, no difference in RV functions would be expected solely caused by RCA diameter ad length. Different findings might be expected if patients with RV hypertrophy deteriorating biphasic RV coronary perfusion were included.

Limitations

This study had several limitations. First, this is a single-center and retrospective study with a limited number of patients. Second, echocardiographic strain measurements were performed according to the modified left ventricle strain settings. Third, myocardial ischemia was determined anatomically not functionally. Echocardiographic and angiographic evaluations were made by a single clinician. Therefore, it was not possible to provide an interobserver agreement.

CONCLUSION

Coronary artery dominancy in the absence of any other condition did not affect RV functions determined by echocardiographic examination.

Ethics Committee Approval: The approval for this study was obtained from Erciyes University Clinical Research Ethics Committee (Decision no: 22017/105, Date: 17.02.2017).

Informed Consent: This is retrospective study, we could not obtain written informed consent from the participants.

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