PREVALENCE OF RIGHT VENTRICULAR DYSFUNCTION IN PATIENTS WITH CORONARY ARTERY DISEASE

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ABSTRACT

Background: Right Ventricular (RV) dysfunction has been associated with increased morbidity and mortality in patients with cardiovascular diseases. Recent advances in diagnostic techniques have made it possible to assess RV function both qualitatively and quantitatively. The assessment of right ventricular (RV) structure and function by echocardiography has been improved by advancements that include Doppler tissue imaging, strain imaging, and three-dimensional imaging. Doppler tissue imaging and strain imaging can be useful for the assessment of regional RV systolic and diastolic function.

Objective: We have conducted this study to assess the prevalence of RV dysfunction in patients with Coronary artery diseases in our population.
Methods: this was a prospective study conducted at Department of Echocardiography of KIHD. All patients with documented CAD were included. RV assessment was made on echocardiography by visual assessment of RV size and function; RV area measurement in four chamber view and RV length in parasternal long axis view; measurement of Tricuspid annular plane systolic excursion (TAPSE) and Tissue Doppler imaging. RV dysfunction was defined as a RV ejection fraction of less than 35%.

Results: 430 consecutive patients fulfilling the inclusion criteria were included in the final analysis. There were 283 (65.81%) male patients and 147 (34.18%) female patients. The mean age of the patients was 53.46 + 12.54 years (range 34-76 years). The mean RV ejection fraction was 43.83 + 10.94% (range 21 – 55). In male patients the mean RV ejection fraction was 44.61 + 9.32% as compared to 42.32 + 11.14% in female patients (p=0.412). A total of 99 (23.02%) patients had RV dysfunction. In male patients RV dysfunction was found in 54 (19.08%) as compared to 45 (30.61) in female patients (p=0.002). This difference is significant statistically.

Conclusion: RV dysfunction is a common finding in patients with CAD. It is more common in female patients.

Key words: right ventricle, coronary artery disease, RV dysfunction, echocardiography.

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INTRODUCTION

Coronary artery disease (CAD) is the commonest cause of morbidity and mortality around the world[1,2]. The primary function of Right Ventricle (RV) is to receive systemic blood and to pump it to the pulmonary circulation for oxygenation. RV dysfunction has been associated with increased morbidity and mortality in patients with CAD, congenital heart disease, valvular heart

disease, pulmonary hypertension and heart failure[3-6]. In recent years, many studies have demonstrated the prognostic value of RV function in CAD[7].

RV failure is a complex clinical syndrome that can result from any structural of functional cardiovascular disorder that impairs the ability of RV to fill or eject the blood. The cardinal clinical manifestations of RV failure are i) fluid retention which may lead to ascitis, edema or anasarca, ii) decreased systolic reserve or low cardiac output, which may lead to exercise intolerance or fatigue, and iii) atrial or ventricular arrhythmias.

RV Dysfunction Assessment:

Echocardiography is the most suitable technique for assessment of RV size and function. For quantitative assessment the RV size should be compared to the left ventricle (LV) size. The normal RV size is approximately two thirds the size of LV in apical four chamber and parasternal long axis views. If RV appears larger than LV and /or shares the apex, then it is dilated. In short axis views, RV should be smaller than LV. RV function is assessed by measuring the RV area in four chamber view and length in parasternal long axis view[8-11].

Another quantitative method to assess RV function is the measurement of tricuspid annular plane systolic excursion (TAPSE). The TAPSE estimates RV systolic function by measuring the level of systolic excursion of the lateral tricuspid valve annulus towards apex in the four chamber view. 5mm ~20% RV ejection fraction, 10mm ~ 30% RV ejection fraction, 15mm ~ 40% RV ejection fraction and 20mm ~ 50% RV ejection fraction[12].

The Doppler index of myocardial performance (Tei index or myocardial performance index) is also used to determine RV function[13]. It is calculated by the following formula:

$$\text{Index} = \frac{\text{IVCT} + \text{IVRT}}{\text{RVET}}$$

IVCT = Isovolumic Contraction Time
IVRT = Isovolumic Relaxation Time
RVET = RV Ejection Time

This method of RV function estimation is not affected by heart rate, loading conditions or the presence and severity of tricuspid regurgitation[13].

Tissue Doppler imaging (TDI) can also be used for quantitative assessment of RV systolic and diastolic function by means of measurement of myocardial velocities. Peak systolic velocity less than 11.5 cm/second identifies the presence of RV dysfunction with a sensitivity and specificity of 90% and 85% respectively[15,16].

There are some other methods also for assessment of RV function including real-time tree dimensional echocardiography, strain rate imaging, radionuclide studies, pressure volume –loop by invasive studies and MRI etc. MRI is the most accurate method for quantitative assessment of RV size and function[17].

In this study we have planned to find out the prevalence of RV dysfunction in patients with documented CAD in our population.

METHODS

This was a prospective study in which consecutive patients fulfilling the inclusion criteria were included. The study was carried out at the Department of Echocardiography of Karachi Institute of Heart Diseases from October 1, 2013 to March 31, 2014.

The inclusion criteria were:

- All patients with documented CAD on echocardiography i.e. segmental wall motion abnormalities
- Any age and gender

Patients with valvular heart disease, congenital heart disease, pulmonary artery hypertension (both primary and secondary) and pulmonary diseases were excluded from the study.

These patients were carefully examined by echocardiography using Toshiba Xario system by experienced technicians and then reviewed by a consultant cardiologist. The seventeen segment module was used for assessment of wall motion abnormalities as recommended by the American Society of Echocardiography.

RV function assessment was made echocardiographically by using following techniques:

a) Visual assessment of RV size and function
b) RV area measurement in four chamber view and RV length in parasternal long axis view.
c) Measurement of Tricuspid annular plane systolic excursion (TAPSE) and RV function was determined as follow:

   if TAPSE is 5mm then RV function is ~ 20%,

   if TAPSE is 10mm then RV function is ~ 30%,

   if TAPSE is 15mm then RV function is ~ 40%,

   if TAPSE is 20mm then RV function is ~ 50%.

d) Tissue Doppler imaging (TDI was used to measure the myocardial velocities. Peak systolic velocity of less than 11.5CM/second was taken as RV dysfunction.

RV dysfunction was defined as a RV ejection fraction of less than 35%, which corresponds to the mean-three standard deviations of the controls[18].

Statistical analysis:

The data was analyzed by using SPSS-16 (Statistical Package for Social Sciences version 16). The data were expressed as mean + standard deviation for normally distributed numeric variable and percentages were used for categorical variables. Chi-square test was used to compare categorical variable and student's t-test was used to compare two groups. A p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 430 consecutive patients fulfilling the inclusion criteria were included in the final analysis. There were 283 (65.81%) male patients and 147 (34.18%) female patients in this study. The mean age of the patients was 53.46 ± 12.54 years (range 34-76 years). The mean age of male patients was 55.14 ± 10.36 and of female patients was 50.23 ± 12.38 years (Table 1).

The mean RV ejection fraction was 43.83 ± 10.94% (range 21 – 55) (Table 2). In male patients the mean RV ejection fraction was 44.61 ± 9.32% as compared to 42.32 ± 11.14% in female patients (p=0.412).

The mean LV ejection fraction was 44.05 ± 14.64%. In male patients if was 46.72% and in female patients it was 41.84%.

Table 3 shows the number of patients with RV dysfunction. A total of 99 (23.02%) patients had RV dysfunction diagnosed by ejection fraction and confirmed by other methods. In male patients RV dysfunction was found in 54 (19.08%) as compared to 45 (30.61) in female patients (p=0.002). This difference is significant statistically.

DISCUSSION

The right ventricle (RV) having a very complex structural geometry is often overlooked and hence its importance in contributing to the overall cardiac function often undermined. RV function has been shown to be a sensitive predictor

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Table 1: Number and age of patients

	No. of patients	Age (years)
Male	283 (65.81%)	55.14 + 10.36
Female	147 (34.18%)	50.23 ± 12.36
Total	430	53.46 ± 12.54

Table 2: Right ventricular ejection fraction

	Mean	Range
Male	44.61 ± 9.32	22 – 55
Female	42.32 ± 11.14	21 – 52
Total	43.83 ± 10.94	21 – 55

Table 3. No. of patients with RV dysfunction

Male	**54 (19.08%)**
Female	45 (30.61%)
Total	99 (23.02%)

of exercise tolerance and is also a major determinant of clinical symptoms in chronic heart failure as well as peri-operative and post-operative survival outcome[19,20]. RV function may be impaired either by primary right sided heart disease, or secondary to left sided cardiomyopathy or valvular heart disease. For instance, pressure or volume overload from an incompetent valve or muscle pathology can affect the RV function. Coronary artery disease may also lead to RV dysfunction when the right coronary artery is occluded. Moreover, in congenital malformation of the heart, the RV may also be affected, particularly when it becomes the main pumping chamber supporting the systemic circulation, e.g. congenitally corrected transposition of the great arteries or univentricular repair at surgery[21]. Lastly, right to left shunting may have perpetual effect on the RV in the form of dilation and impairment through volume overload as in the case with atrial and ventricular septal defects[21,22]. Based on the above, it is clear that understanding the anatomy as well as normal and abnormal physiology of the right heart is of significant importance.

Similar to the left ventricle, maintaining the coronary flow to the RV myocardium is crucial, particularly when RV systolic pressure is raised. For instance, in pulmonary hypertension, where RCA pressure may be increased or remained unchanged, there is an increase in oxygen demand by the myocardium. Since RV perfusion occurs during both diastole and systole, the systolic component is reduced as a result of the raised chamber pressures[23,24]. Acute RCA occlusion proximal to the RV branch often results in RV free wall dysfunction and in multivessel coronary artery disease there is significant ischemic long axis dysfunction with stress which seems to affect the cardiac output[25]. The long lasting ischemic right ventricle becomes stiff, dilated and volume dependent which contributes to RV dysfunction. Patients with RV infarction commonly respond positively to volume treatment and early reperfusion enhances recovery of right ventricular performance and improves clinical outcome and survival[26]. We have conducted this study to find out the prevalence of patients with RV dysfunction in patients with CAD in our population. RV function and regional wall motion can be determined with right ventricular angiography, radionuclide ventriculography, two-dimensional echocardiography or MRI with their own respective limitation. Due to the complex anatomy of the RV, assessment of its function can be problematic. The right ventricle is a crescent shaped three dimensional cavity and its transverse axis is wrapped around the LV[27].

We have conducted this study to see the prevalence of RV dysfunction in patients with CAD in our population. So far no data is available in this regard. We have used echocardiography for RV function assessment as this modality is widely available and the results are reproducible. Details have been described in the methods. However, some newer techniques like 2D speckle tracking, strain SI, and three dimensional and four dimensional imaging of RV function analysis were not done as these techniques are not available in our laboratory.

Our data shows that the prevalence of RV dysfunction in patients with CAD is 23.02% in our

population. This data is comparable to the data reported in the western population[28]. La Vecchia L, et al have reported RV dysfunction was present in 18% of their patients with a previous history of myocardial infarction[29]. Our study also shows that RV dysfunction is more common in female patients as compared to male patients (19.08% vs 30.61%). This difference was significant statistically (p=0.002).

More studies with large sample size should be conducted using newer techniques of RV function assessment to validate these results.

CONCLUSION

We have concluded that RV dysfunction is a common finding in patients with CAD. Our study shows that RV dysfunction is as common in our population as reported in the western population. Our study also shows that it is more common in female patients as compared to male patients. We recommend that RV function should be assessed in all patients with CAD. Further large scale studies are required to validate our data.

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