RESEARCH

# A CLINICAL STUDY THE RELATION OF RIGHT ATRIAL VOLUME INDEX WITH CHRONIC SYSTOLIC HEART FAILURE

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## Abstract

**Background:** Heart failure (HF) is a syndrome associated with high morbidity and mortality and considerable economic burden. It is the third most prevalent cardiovascular disease and the third leading cause of cardiovascular death in the United States (2). Once diagnosed, HF continues to portend a grim prognosis despite advances in treatment. The aim is to study the relation of RAVI with profiles of patients with chronic systolic HF and to study the relation of RAVI with prognosis in patients with chronic systolic HF. **Materials and Methods:** Patients with chronic systolic heart failure attending in the Cardiology OPD or admitted in the Cardiology ward was studied for this study with the age of 18 to 75 years with left ventricular ejection fraction (LVEF) </=35%. **Result:** There is a good correlation between RAVI and worsening right ventricular systolic parameter measured by TAPSE. There is a good correlation between RAVI and worsening left ventricular systolic function. RAVI is an independent predictor of adverse outcome (hospitalization for acute HF episode, death) in patients with chronic systolic HF. Age, sex and etiology of HF has no correlation with RAVI and adverse outcome in patients with chronic systolic HF. **Conclusion:** Patients with chronic systolic HF may express the severity of RV systolic dysfunction and this quantitative echocardiographic marker can be used to identify patients with poor prognosis.

## INTRODUCTION

Heart failure (HF) is a syndrome associated with high morbidity and mortality and considerable economic burden. It is the third most prevalent cardiovascular disease and the third leading cause of cardiovascular death in the United States. Once diagnosed, HF continues to portend a grim prognosis despite advances in treatment.

Several etiological factors have been described for HF. Of these, coronary heart disease (CHD) and hypertension account for approximately three-fourths of all HF, although their relative importance differs according to age, sex, and race. There are approximately 5 million people with HF in the United States. There has been a doubling of HF prevalence in the past 25 years. More than half a million new cases of heart failure are diagnosed each year in the United States, and this incidence is expected to rise to 772,000 new cases per year by 2040.The lifetime risk of developing heart failure is estimated at 20% in both men and women.[1,2]

Reliable estimates of heart failure are lacking in India because of the absence of a surveillance programme to track incidence, prevalence, outcomes and key causes of heart failure. Nevertheless, the incidence and prevalence rates of heart failure are rising due to population, epidemiological and health transitions. Based on disease-specific estimates of prevalence and incidence rates of heart failure, conservatively estimated prevalence of heart failure in India due to coronary heart disease, hypertension, obesity, diabetes and rheumatic heart disease is to range from 1.3 to 4.6 million, with an annual incidence of 491 600–1.8 million. The double burden of rising cardiovascular risk factors and persistent 'pre-transition' diseases such as rheumatic heart disease,

limited healthcare infrastructure and social disparities contribute to these estimates.[3]

Despite significant advances in medical and surgical treatment, the prognosis of patients with chronic heart failure remains poor and 1-year survival of selected patient groups may even fall below 50%.[4] One of the ways to improve their prognosis is the identification of patients at high risk of cardiac events. Such patients may be submitted to more intensive medical management or may be rapidly referred for bypass surgery or heart transplantation. An accurate prognosis is, therefore, essential in designing treatment protocols and judging therapeutic risks and benefits of any intervention to achieve these goals. The challenge of determining prognosis in any patient is extraordinary and a grave responsibility lies on the treating physician.

Despite the knowledge of a high number of factors accounting for increased mortality, the therapeutic results are not satisfactory, and there is no agreement on which factors or their combination are the best to predict the high risk of cardiac death or non-fatal cardiac events. Many of the prognostic parameters are not routinely investigated because of their invasive nature, high cost or low availability. So, the choice of a non-invasive, widely available, inexpensive, and accurate method still represents a problem.

The reports published thus far have suggested a high potential of right ventricular systolic function parameters for the prediction of cardiac events. Reports on prognosis of patients with heart failure published thus far concordantly proved the increase in mortality and frequency of non-fatal cardiac events in patients with right ventricular systolic dysfunction. Right ventricular ejection fraction >0.35 at rest and exercise is a more potent predictor of survival in advanced heart failure than mean peak oxygen consumption (V02) and mean peak age- and gender-adjusted percent predicted oxygen consumption (%VO2). BNP levels are related to the severity of RV dysfunction.[5,6]

There are several methods of assessing the right ventricular function: thermodilution technique during the right heart catheterization, ventriculography with contrast agents, radioisotope ventriculography, nuclear magnetic resonance imaging, and echocardiography. In most studies, the right ventricular ejection fraction obtained by radioisotope ventriculography or thermodilution technique was used. Catheterization, nuclear magnetic resonance imaging, and radioisotope ventriculography most often determine the right ventricular ejection fraction. The main limitations of these methods are a relatively high cost, demand for time and, in the case of catheterization, its invasive nature and cannot be used at the bedside.

Standard two-dimensional echocardiographic evaluation of right ventricular volumes and ejection fraction is inaccurate because it is difficult to define endocardial surfaces (right ventricular trabeculation and often suboptimal quality of right ventricular imaging) and calculating volumes is also a problem because of the complexity of the shape of the right ventricle. The accuracy of echocardiographic evaluation of right ventricular function can be improved by the application of a contrast agent, but it increases the cost of the investigation and may not be comfortable for all patients. The ability to visualize the right atrium (RA) allows a quantitative, highly reproducible assessment of the RA volume that can be indexed to body surface area.[7]

In the Assessment of Doppler Echocardiography for Prognosis and Therapy (ADEPT) study it was hypothesized that RA volume can serve as a quantitative marker of RV dysfunction severity. The aim of the study was to determine the relationship between right atrial volume index (RAVI) and echocardiographic indices of left and right side systolic and diastolic performance, as well as long-term prognosis for patients with chronic systolic HF. The study has the conclusion that "In patients with chronic systolic HF, RAVI is a determinant of right-sided systolic dysfunction. This quantitative and reproducible echocardiographic marker provides independent risk prediction of long-term adverse clinical events." Since then some studies has been done regarding the prognostic value of RAVI in chronic systolic heart failure, but the data are not large. We made this study to see the relation of RAVI with profiles (in relation to age, sex, etiology of HF, NYHA functional class, left ventricular ejection fraction) and prognosis (HF hospitalization, all-cause mortality) in patients with chronic systolic HF in this tertiary institute.

**So, the aims and objectives of this study are as follows:**

1. To study the relation of RAVI with profiles of patients with chronic systolic HF (age, sex, etiology of HF, NYHA functional class, left ventricular ejection fraction [LVEF], RV systolic function measured by tricuspid annular plane systolic excursion [TAPSE]).
2. To study the relation of RAVI with prognosis in patients with chronic systolic HF (HF hospitalization, all-cause mortality).

## MATERIALS AND METHODS

Patients with chronic systolic heart failure attending in the Cardiology OPD or admitted in the Cardiology ward was studied for this study. Inclusion and Exclusion Criteria was like the Inclusion and Exclusion Criteria taken in previous studies on this topic.

**Inclusion Criteria:**

18 to 75 years of age, with left ventricular ejection fraction (LVEF) </=35%.

**Exclusion Criteria:**

Mitral stenosis or history of mitral valve surgery, Severe mitral regurgitation, Severe aortic stenosis (peak velocity 4 m/s), Aortic regurgitation, Acute


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coronary syndrome within last 30 days, Chronic renal failure and Malignancy.

Informed consent of patients was taken. Comprehensive trans-thoracic echocardiography was performed using commercially available Siemens echo machine. Two-dimensional and color Doppler imaging was performed in standard parasternal and apical views. RA area was measured in the apical 4-chamber view at end systole using Simpson's method, and was indexed to body surface area by dividing the volume by body surface area, which was calculated using the Du Bois and Du Bois formula.[7] RAVI was averaged over 3 cardiac cycles and it was 5 cycles for atrial fibrillation (AF). Clinical follow-up was for 1 year prospectively tracked by scheduled OPD and telephone follow-up. For prognosis the primary endpoint was the combined risk of hospitalization for acute HF episode or death. Hospitalization for HF was defined as an admission for worsening HF in which intravenous therapy for HF was needed. Non-ischaemic dilated cardiomyopathy was diagnosed after the exclusion of coronary artery disease by history, ECG, echocardiography and coronary angiography as needed.

Appropriate Statistical analysis was applied using SPSS software. For profiles of patients with chronic systolic heart failure, age, sex, etiology, LVEF and RV systolic function measured by TAPSE was independent variable, and RAVI was dependent variable. Among the independent variables age, LVEF and TAPSE are continuous variable and sex is dichotomous categorical variables and etiology is nominal categorical variable. RAVI is a continuous variable. Relation between RAVI and continuous variables was studied by linear regression, and relation between RAVI and categorical variables was studied by t test.

## RESULTS

Total 57 patients were enrolled for the study. 7 patients were lost to follow up. Primary end point event occurred in 29 patients.

**Table 1: Demographic in correlation with RAVI (Right Atrial Volume Index).**

| Variable | RAVI values | P- Value |
|---|---|---|
| Age | 47.9+5.1 | .918. |
| Gender | | |
| Male | 49.15+9.5 | 0.393 |
| Female | 44.23+8.02 | |
| Etiology | | |
| ischemic | 47.86+9.55 | 0.449 |
| Non ischemic | 46.18+8.4 | |
| NYHA | | |
| Class II | 37.66+1.71 | 0.001 |
| Class-IV | 51.81+7.3 | |

RAVI shows no relation with age, gender, ethiology and NYHA.

RAVI shows strong correlation with left ventricular systolic function as measured by LVEF. Increased RAVI was correlated with decreased left ventricular systolic function as measured by LVEF. p value was .001. RAVI shows strong correlation with right ventricular systolic function as measured by TAPSE. Increased RAVI was correlated with decreased right ventricular systolic function as measured by TAPSE. p value was .001.

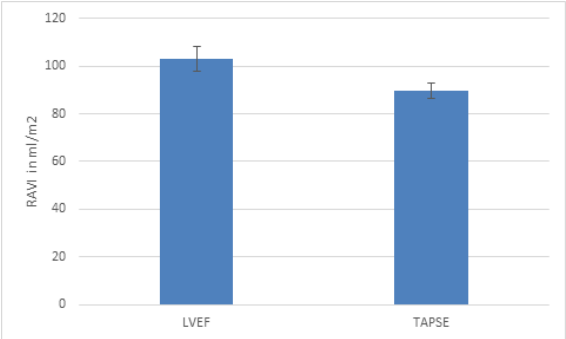


**Figure 1: Right atrial volume index in correlation with left ventricular systolic function and tricuspid annular plane systolic excursion**

**Table 2: RAVI in correlation with primary end point events.**

| Primary end point events. | Number of cases | Mean +SD | P- Value |
|---|---|---|---|
| Y | 29 | 54.55+4.99 | 0.005 |
| N | 21 | 37.71+1.7 | 0.005 |

RAVI shows strong correlation with primary end point events. Increased RAVI was correlated with increased primary end point events. p value was .005.

**Table 3: In short the result from analysis of the data of this study**

| Variable | P-Value |
|---|---|
| Age | NS; p value .918 |
| Sex | NS; p value .393 |
| Etiology | NS; p value .449 |
| LVEF | NS; p value 0.001 |
| TAPSE | NS; p value 0.001 |
| Primary end Point Events | SIG; p value .005 |

Age, sex and etiology of heart failure have no relation with the primary end point events.

## DISCUSSION

In our study age, sex and etiology of heart failure has no correlation with primary end point events when age, sex and etiology of heart failure were used as predictor variables and primary end point events was used as outcome variable. This inference is in commensurate with the study made by Darahim K.[8] In that study age, gender and etiology of heart failure had non-significant relation with the incidence of primary outcome events. In the present study increased RAVI was significantly correlated to increased NYHA class- patients in NYHA class III and IV had significantly increased RAVI than patients in NYHA class II. Earlier studies also


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showed that. RAVI>/=41.6 ml/$m^2$ (optimal ROC cut-off) had a 68% sensitivity and a 92% specificity (p< 0.0004) for predicting NYHA functional class>/=3.[9] In our study RAVI shows strong correlation with left ventricular systolic function as measured by LVEF. Increased RAVI was correlated with decreased left ventricular systolic function as measured by LVEF. This correlation was proved in earlier studies made by Sallach J A et al,[9] and Darahim K.[8] RAVI was shown strongly correlated with RV systolic function as measured by TAPSE in this study. This correlation was also proved in the above mentioned studies.[8,9] The most important finding of our study was that RAVI has significant correlation with primary end point events defined by hospital admission for heart failure and death. The study made by Darahim K,[8] showed that, RAVI remained an independent predictor of adverse outcome when RV echocardiographic markers such as RVFAC, Satri, tricuspid E/A ratio, and hepatic vein S/D ratio are considered. Sallach et al,[9] showed that RAVI is an independent predictor of cardiovascular events in patients with chronic stable heart failure. RAVI remained an independent predictor of poor outcomes after adjusting for age, brain natriuretic peptide, LVEF, RV systolic dysfunction stage, and tricuspid E/Ea ratio (p= 0.005). In ROC analysis, RAVI>/= 30.6 ml/m2 (optimal ROC cutoff) had a 78% sensitivity and a 77% specificity (p< 0.0001) for predicting RV systolic dysfunction stage>/= 3.[10] So, our study has similar results like the previous ones on this topic. Decreased LVEF and RV systolic function measured by TAPSE was associated with increased RAVI; and RAVI was strongly correlated to adverse clinical events as described by hospital admission for HF and death in patients chronic systolic heart failure.

**Limitation of the study**

In spite of identifying a strong relationship between RAVI and adverse event in patients with chronic systolic heart failure, there are several limitations to our study. Our study population was relatively small. Follow up period was only 1 year. The RA volumes were calculated using Simpson's method from only 1 view, the apical 4-chamber view. This view places the RA in the far field, diminishing lateral resolution and adversely affecting visualization of the RA endocardium. Present study did not include biological markers for adverse outcome in heart failure such as brain natriuretic peptide, but this would have increased the cost of the present study. Invasive hemodynamic data were not available for correlation in any study patients. Last, our study population consisted of patients with significant LV systolic dysfunction-there was no control group with normal LV function.

## CONCLUSION

There is a good correlation between RAVI and worsening right ventricular systolic parameter measured by TAPSE. There is a good correlation between RAVI and worsening left ventricular systolic function. RAVI is an independent predictor of adverse outcome (hospitalization for acute HF episode, death) in patients with chronic systolic HF. Age, sex and etiology of HF has no correlation with RAVI and adverse outcome in patients with chronic systolic HF. Our findings indicate that, in patients with chronic systolic HF, the RAVI may express the severity of RV systolic dysfunction and this quantitative echocardiographic marker can be used to identify patients with poor prognosis.

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