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Effect of coronary artery bypass grafting on function of right ventricle in patients with severe left ventricular dysfunction

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ABSTRACT

Objectives: Both the ventricles work in synergy creating interdependence. Effect of severe left ventricle dysfunction on right ventricle has not been evaluated. This study is planned to observe incidence and its effect in patients undergoing coronary artery bypass grafting (CABG).

Methods: Patients undergoing CABG between July 2009 and July 2010 with LV ejection fraction 40% or less for 6 months were included in this study. Echocardiography parameter of tricuspid annular plane systolic excursion (TAPSE in mm) was used to define right ventricular (RV) dysfunction. TAPSE <15 mm Group I, n = 9 and TAPSE > 15 mm Group II, n = 31.

Results: RV free wall dysfunction (TAPSE <15 mm) was observed in 22.5% patients, which increased to 52.5% following operation. However, comprehensive RV function did not change postoperatively (Myocardial Performance Index, MPI of >0.40 in 42.5% patients preoperatively to 50% cases postoperatively, p = 0.1). Patients in group I have reduced ejection fraction of LV (25% in group I vs 35% in group II, p = 0.03) and higher RV dysfunction (MPI 0.40 in group I vs. 0.19 in group II). Postoperatively, there is worsening of RV and inter-ventricular septum (IVS) function. However, patients with better IVS function preoperatively maintained function postoperatively (r = 0.742, p = 0.001) with better RV function (r = 0.592, p = 0.003).

Conclusion: RV dysfunction is present in high percentage of patients with severe LV dysfunction. Preserved function of IVS preoperatively is maintained postoperatively and it predicted better postoperative free wall and comprehensive RV function. Proximal block in right coronary artery is associated with free wall RV dysfunction.

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Right ventricular (RV) dysfunction is a major risk factor in coronary artery disease (CAD) and patient undergoing revascularization with this combination.¹ Incidence of RV dysfunction is reported in about 20% cases of CAD.² Depressed function of RV in CAD is due to multiple factors; most prominent direct factor is infarction of RV reported in 40% cases of acute myocardial infarction, and is associated with high mortality if operated.³ The level of block in the right coronary artery⁴ has reportedly affected severity of RV dysfunction. Moreover, RV function is also affected directly by dysfunction of left ventricle because of ventricular interdependence.⁵ Dysfunction of RV caused by infarction improves with time because of multiple factors, such as improvement in the left ventricular function, favourable myocardial supply and demand ratio because of lower intra-ventricular pressure and thus adequate supply and thin myocardium requiring lesser demand. Function of RV takes close to 6 months to recover.⁶ It recovers so well that RV failure following RV infarction is rare.⁷ Considering these facts, RV function may thus be depressed early in cases with myocardial infarction and may be reported differently seen in different stages of recovery. There are no data available on incidence of RV dysfunction in patient long after the initial acute event in those who develop severe LV dysfunction. This study was planned to observe these patients and the effect of coronary artery bypass grafting (CABG) in this cohort.

1. Materials and methods

This is a prospective study of patients undergoing primary CABG. The research committee and institute ethics committee cleared the research protocol. Consecutive patients of CAD between July 2009 and July 2010 with left ventricular ejection fraction of lower than 40% for at least 6 months were included in the study. All patients were in normal sinus rhythm. Patients with atrial fibrillation, acute myocardial infarction of <90 days duration and cardiogenic shock were excluded. Forty patients were enrolled for this study. Since LV contraction and movement of inter-ventricular septum (IVS) contribute to about 25% of RV function, this contribution is obtunded when LV function is depressed with reduced IVS movement and change of its shape. These patients are best suited to study the incidence of long standing true dysfunction of RV as left ventricular contribution is minimal.⁸

2. RV functions by echocardiography

Routine trans-thoracic echocardiography is performed on GE 6000 machine with 3.5 Htz probe. LV end diastole and systole dimensions and ejection fraction are assessed by 2-dimension echocardiography. IVS shape is evaluated in 4-chamber view with reference to its shape defining curvature towards RV, left ventricle or straight. Tissue Doppler is utilized to measure the maximum systolic velocity of IVS in cm/s.⁹ Systolic function of RV is evaluated by tricuspid annular plane systolic excursion (TAPSE) measured in mm. This is an effective test reported to be associated with prognosis in post-cardiac surgery period. A value of <15 mm was considered RV dysfunction.¹⁰ Myocardial

Performance Index (MPI) represents a comprehensive assessment of combined systolic and diastolic function. MPI is calculated by assessment of RV inflow and outflow time (isovolumic contraction time + isovolumic relaxation time/ejection time). A value of >0.40 is considered as RV dysfunction.¹¹ TAPSE is marker of free wall function of the RV that is a true representative of its involvement and is thus considered for division of these patients into two groups. MPI is considered as a more holistic marker of RV function inclusive of relaxation of RV (restriction) and ventricular interdependence and is therefore used for assessment of outcome in these patients.

Forty patients met the inclusion criteria out of total 235 patients undergoing primary CABG during a year in the unit. Based on the criteria of TAPSE, patients are divided into 2 groups (Group 1 of TAPSE <15 mm, n = 09 and Group 2 of TAPSE >15 mm, n = 31).

All the patients underwent off pump CABG through a standard median sternotomy. Tissue stabilization is achieved by octopus evolution (Medtronic Inc. MN, USA) and intra-coronary shunts are used during distal coronary anastomosis. Deep pericardial stay sutures are used for positioning of the heart as described in detail by author previously.¹² Pulmonary artery pressure and cardiac index are calculated in all cases. Cardiac index is calculated pre-induction followed by post-induction and following every graft 3 min after the heart is returned back to the pericardial cradle from its position for performing that graft. All the preoperative echocardiographic parameters for LV and RV function are repeated 15 days following discharge.

3. Statistical analysis

Data are expressed in median and range in minimum and maximum expression of particular variable. Percentage is used to express the incidence of particular variable in the whole group. Statistical significance is expressed by *p* value of <0.05. Wilcoxon Anderson test is used in finding the significance in the same group preoperatively and postoperatively. Similarly, Mann-Whitney *U* test is used for comparing variables of RV and LV function in two groups. Categorical variable are analyzed by chi-square test. Pearson's correlation is used to explore dependency of various RV and LV parameters.

4. Results

Demographic details of patients with their risk factor, both clinical and echocardiographic, are presented in [Table 1](#). Echocardiographic indicators of RV function and interdependence of ventricles as well as the changes they underwent following surgical revascularization are presented in [Table 2](#). Though LV size reduced and function improved, it was not of statistical significance following CABG. RV dysfunction in all patients is present in 22.5% cases (9 out of 40) and it increased to 52.5% (21 out of 40) postoperatively. IVS is observed as straight in 47.5% (19 out of 40) and it increased to 60% (24 out of 40), *p* = 0.05. But overall comprehensive RV function expressed by MPI of <0.40 is present preoperatively in 42.5% cases (17 out of 40) and it did not change much as it presents in 50% cases

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