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Original Article

Early and six-month assessment of bi-ventricular functions following surgical closure of atrial septal defect



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ABSTRACT

Background: The effect of surgical closure of atrial septal defect (ASD) on biventricular functions is not well studied. We studied effect of surgical closure of ASD on bi-ventricular functions.

Methods: Patients undergoing surgical closure of ASD from December 2007 to June 2009 had 3 sequential echocardiograms examination: pre-procedure, post surgery at 1-month and at 6-month of follow up. Pulse Doppler velocities across mitral and tricuspid valves were measured as peak early diastolic (E wave) and peak late diastolic (A wave). Tissue Doppler velocities across lateral wall of both right ventricle (RV) and left ventricle (LV) were measured as peak early diastolic (E'), peak late diastolic (A'), and peak systolic (S') wave. Radionuclide angiography was performed to assess RV and LV ejection fraction at baseline and at 1-month follow up.

Results: The mean age of 20 enrolled patients was 21.85 ± 10.9 years; 8 females & 12 males. Trans-tricuspid flow velocities significantly decreased following surgery at one and 6-month ($p < 0.005$). There was no significant change in trans-mitral flow velocities at one and 6-months. Tricuspid and mitral E/A ratio and E/E' ratio also had an insignificant change following surgery. There was no significant change in LV ejection fraction as assessed by echocardiography ($p = 0.132$) and radionuclide scan ($p = 0.143$). Right ventricular ejection fraction had a significant improvement at 1-month of follow up ($p = 0.005$).

Conclusions: There was a significant improvement in RV systolic function and an insignificant change in RV and LV diastolic functions following surgical closure of ASD.

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1. Introduction

Atrial septal defect (ASD) accounts for 25–30% of congenital heart defects, which are diagnosed during adulthood.¹ Most individuals with isolated ASD become symptomatic in third or fourth decade of life.² It can cause right ventricular dysfunction, pulmonary artery hypertension, atrial arrhythmias, thrombo-embolism and stroke. Its closure is recommended to avoid these late complications.² Echocardiography is the best imaging modality for diagnosis and hemodynamic evaluation of ASD. Nuclear imaging with Equilibrium Radionuclide Ventriculography (ERNV) using 99mTc-perchnetate provides an accurate measurement of bi-ventricular systolic functions in congenital heart disease. In the present study, we prospectively enrolled patients subjected for surgical repair of ASD and studied (i) bi-ventricle systolic and diastolic functions by assessing mitral and tricuspid valve pulsed wave and tissue Doppler velocities (DTI) at baseline, and post operatively at 1 and 6-month, following surgery. (ii) Right and left ventricular ejection fraction using ERNV at baseline and at 1-month, following surgery.

2. Methods

Twenty consecutive patients of isolated ASD subjected for surgery from December 2007 to June 2009 were enrolled in the study. All patients underwent detailed trans-thoracic echocardiography examination (3.5 MHz transducer, Vivid System Five, GE Vingmed, Horten, Norway) before, 1-month later and 6-months after surgery. Bi-ventricular ejection fraction was calculated using ERNV at baseline and 1-month after surgery. The study was approved by institutional ethical committee.

2.1. Echocardiographic measurements

Atrial septal defect was measured in apical 4-chamber and sub-costal view. Electrocardiography gated pulse wave Doppler velocities such as peak inflow velocities at early (E) and late (A) diastole were measured across mitral and tricuspid valves. Doppler tissue velocities in early diastole (E'), late diastole (A') and peak systolic (S') wave were measured by the spectral mode of the myocardial Doppler imaging (5 MHz) in two positions: (1) the basal right ventricle (RV) free-wall – tricuspid annular junction, and (2) the basal left ventricle (LV) free-wall – mitral annular junction. The standard para-sternal long-axis view just below the tip of the mitral valve leaflets was used for M-mode measurements. Left ventricle ejection fraction was measured by modified Simpson's method in apical 4-chamber view. The RV dimension was measured at mid level of ventricle at end-diastole, in apical RV focused four-chamber view. An RV dimension of ≥ 35 mm was considered for RV dilatation as per American Society of Echocardiography guidelines.³

2.2. Radionuclide study

Radionuclide angiography was performed according to American Society for Nuclear Cardiology recommendation.⁴

Electrocardiogram gated Multigated Radionuclide Angiography (MUGA) was performed in each patient after labeling their red blood cells in vivo. Initially, an intra-venous dose of 2–3 mg Stannous Pyrophosphate was given. Twenty minutes later, a dose of 0.2 mCi (7.4 MBq)/kg body weight, maximum dose of 20 mCi (740 MBq) of sodium technetium 99m perchnetate (Na99mTcO₄) was injected. Cardiac imaging was acquired on a single headed SPECT gamma camera (MPR GE Healthcare Milwaukee, USA). ERNV studies were acquired on computer using a pixel matrix. Each study was acquired for approximately 5 min, collecting data from 300 to 400 cardiac cycles. The data thus obtained was analyzed to measure RV ejection fraction by first-pass radionuclide angiography (FPRNA) and LV ejection fraction by MUGA. A permission was taken from institute ethics committee for the study.

2.3. Statistical analysis

Statistical analysis was performed using SPSS 15.0 software. After assessment of approximate normal distribution, continuous variables were presented as mean \pm 1 SD. The Wilcoxon matched pair test was used to compare baseline, one and six months post surgery variables. Trend for continuous variable over 6 months was assessed using Freidman's test. Ejection fraction of left and right ventricle derived from radionuclide test was compared before and after surgery using the paired t – test. A *p* value of <0.05 was considered statistically significant.

3. Results

Among 20 patients enrolled in the study, there were 8 females and 12 males. The mean age was 21.85 ± 10.9 years. All patients were in sinus rhythm and had no associated cardiac defects. Seventeen patients had ostium secundum defect and three had sinus venosus defect. Mean size of the defect was 27.10 ± 8.8 mm (Range 12–33 mm). Pericardial patch repair was performed in 18 and direct suturing in 2 patients. There was no peri-operative complication.

Trans-tricuspid flow velocities significantly decreased following surgery. Tricuspid E velocity decreased from 103.35 ± 22.9 cm/s at baseline to 63.55 ± 17.8 cm/s at 1-month and to 63.60 ± 19.4 cm/s at 6-months (*p* = 0.001). Similarly tricuspid A velocity decreased from baseline as 62.75 ± 19.4 cm/s to 42.95 ± 11.1 cm/s at 1-month and to 44.25 ± 11.3 cm/s at 6-months (*p* = 0.001). Tissue Doppler velocities at tricuspid annulus also showed a significant decrease: for E' wave, 21.39 ± 6.5 to 13.28 ± 5.3 to 311.67 ± 4.2 cm/s (*p* < 0.001); for A' wave 16.40 ± 5.4 to 10.67 ± 4.3 to 8.6 ± 2.73 cm/s (*p* < 0.001); and for S' wave, 17.75 ± 3.5 vs 11.55 ± 4.9 vs 11.60 ± 3.4 cm/s (*p* < 0.001). However, tricuspid inflow velocity ratio such as E/A ratio (1.7 ± 0.63 to 1.5 ± 0.34 to 1.5 ± 0.042 , *p* = 0.142) and E/E' ratio (5.03 ± 1.1 to 5.5 ± 2.7 to 6.19 ± 2.6 , *p* = 0.086) showed an insignificant change at follow-up. All these values are described as – at baseline, at 1-month and at 6-month of follow up (Table 1). There was a significant decrease in RV dimension at one and 6-month of follow up following repair (41.30 ± 13.0 to 30.15 ± 8.4 to 24.60 ± 7.9 mm; *p* < 0.001) (Table 1). Right ventricle dilatation

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