Journal of the American College of Cardiology
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Published by Elsevier Inc.

Vol. 45, No. 4, 2005
ISSN 0735-1097/05/$30.00
doi:10.1016/j.jacc.2004.10.052

Improvements in Cardiac Form and Function After Transcatheter Closure of Secundum Atrial Septal Defects

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OBJECTIVES We set out to study the effect of transcatheter closure of atrial septal defect (ASD) on right ventricular (RV) and left ventricular (LV) function assessed by myocardial performance index (MPI), as well as left atrial (LA) volumes.

BACKGROUND The hemodynamic response to the closure of ASD is well-documented in surgically treated patients. However, few studies have documented echocardiographic evaluation of ventricular function in patients undergoing transcatheter closure of ASDs.

METHODS Pre- and post-ASD device closure echocardiograms of 25 consecutive patients were retrospectively reviewed. Measurements of RV and LV MPI and LA volumes were made.

RESULTS Twenty-five patients with an average age of 45.5 ± 16.3 years underwent transcatheter closure of ASD. There was statistically significant improvement in RV MPI (0.35 to 0.28, $p = 0.004$), LV MPI (0.37 to 0.31, $p = 0.04$), and LA volume index (25.7 to 21.8 ml/m^2, $p < 0.001$) after closure of ASD.

CONCLUSIONS Device closure of ASDs leads to improvement of both RV and LV function as well as reduction in LA volume. These hemodynamic improvements provide insights into the symptomatic benefits gained in closure of ASDs using the transcatheter approach. (J Am Coll Cardiol 2005;45:499–504) © 2005 by the American College of Cardiology Foundation

Atrial septal defects (ASDs) account for approximately 10% of all congenital heart lesions (1) and can sometimes result in the development of pulmonary hypertension, atrial arrhythmias, and right heart decompensation (2). Although surgical closure of ASDs has been the mainstay of treatment, and although both medium- and long-term studies show excellent results (3), there remains significant morbidity and mortality associated with surgical repair (4). Transcatheter closure of isolated secundum ASDs has been established as a treatment alternative to surgical closure (5). Although there are a number of short-term studies reporting its utility (6), no data are currently available on its long-term benefit.

Studies have shown hemodynamic and functional improvement in right ventricular (RV) function after both surgical and device closure of ASDs (7,8). However, there is a paucity of data assessing left ventricular (LV) function after closure of ASDs. Myocardial performance index (MPI) was initially described by Tei et al. (9) as a measure of combined LV systolic and diastolic function. Although MPI has been used to study patients with congenital heart disease, the effect of transcatheter closure of ASD on LV MPI and RV MPI has not been studied to date.

It is generally agreed that surgical closure of ASDs in adulthood is associated with significant mortality benefit; however, there is limited benefit when it comes to prevention of atrial arrhythmias (2). An increase in left atrial (LA) diameters predicts the development of atrial fibrillation, stroke, and death (10). Currently, no data exist on LA volumes in patients with ASD and the effect of closure on these volumes.

The goals of this study were: 1) to assess the effect of transcatheter closure of ASDs on RV and LV function; and 2) to study the effect of ASD closure on LA and LV volumes.

METHODS

Population. After approval from the institutional research ethics board, adult patients who had undergone transcatheter closure of secundum ASDs between June 1, 2002, and June 1, 2003, were identified from the Toronto Congenital Cardiac Center for Adults database. Patients were excluded if they were clinically unstable, were not in sinus rhythm at the time of either echocardiographic examination, or had inadequate echocardiographic assessment. Demographic information, clinical status, and the size of device implanted were collected from the medical records.

The Amplazer septal occluder (AGA Corp., Golden Valley, Minnesota) was used for ASD closure as previously described (11). The device size chosen was either 2 mm or 10% greater than the stretched diameter size, whichever was larger.

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Manuscript received July 29, 2004; revised manuscript received October 16, 2004, accepted October 25, 2004.

Abbreviations and Acronyms

ASD	= atrial septal defect
EF	= ejection fraction
IVRT	= isovolumic relaxation time
LA	= left atrial/atrium
LAVI	= left atrial volume index
LV	= left ventricle/ventricular
LVEDD	= left ventricular end-diastolic diameter
LVESD	= left ventricular end-systolic diameter
MPI	= myocardial performance index
RV	= right ventricle/ventricular

Echocardiography. Echocardiographic studies were performed in the standard manner using commercially available systems. Doppler recordings of LV and RV inflows (interval *a*) and outflows (interval *b*) were used for the calculation of MPI for each ventricle (9) (Fig. 1). Measurements were made on four consecutive beats, and MPI was calculated from the average values as per the formula: MPI = (a − b)/b.

Left ventricular volumes were determined using the Teicholz method (12). Left ventricular ejection fraction (EF) was estimated using the Quinones method (13); LA volumes were estimated using a length-diameter ellipsoid method (14) (Fig. 2) and were indexed to body surface area, and left atrial volume index (LAVI) was reported for each patient. Echocardiograms were examined by the primary reader (O.S.) who was blinded to the clinical information.

Reproducibility. Intraobserver variability was assessed in a randomly selected subset of 10 patients by repeating all measurements on a separate occasion. To test the interobserver variability, all measurements were performed offline by a second observer (M.S.) who was blinded to the clinical data as well as the results of the initial echocardiographic examination.

Statistical analysis. All statistical analyses were done using SPSS 12.0 (SPSS Inc., Chicago, Illinois). Data are expressed as mean values ± SD. Comparisons between pre- and post-device closure data were made using Wilcoxon

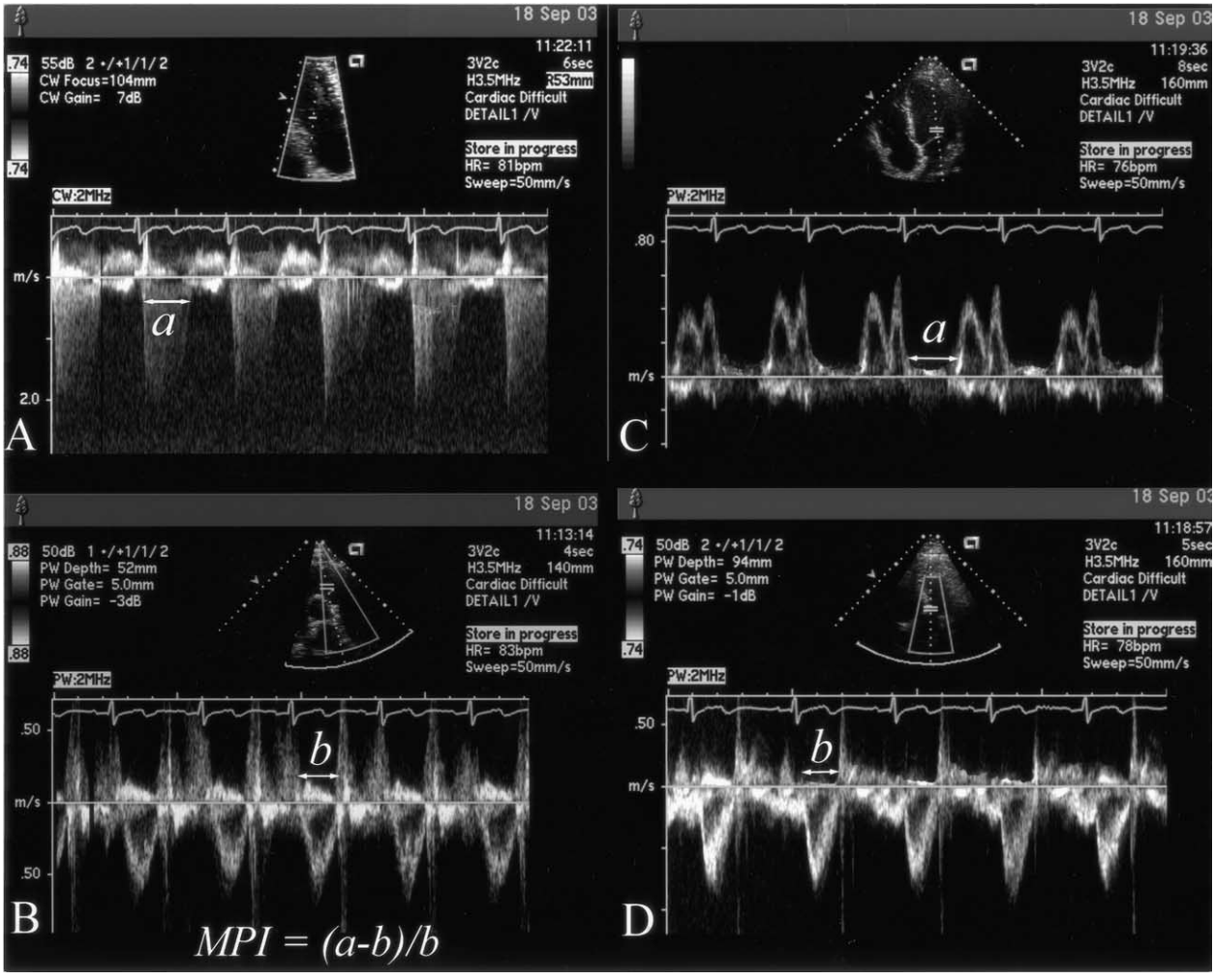

Figure 1. Spectral Doppler recordings of tricuspid regurgitation jet **(A)**, right ventricular outflow **(B)**, mitral inflow **(C)**, and left ventricular outflow **(D)** in a patient with previous device closure of a secundum atrial septal defect. Intervals *a* and *b* are used to calculate myocardial performance index (MPI) for the right and left ventricle as per the formula: MPI = (a − b)/b. bpm = beats/min; CW = continuous-wave Doppler; HR = heart rate; PW = pulsed-wave Doppler.