

Immediate and short-term effects of transcatheter device closure of large atrial septal defect in senior people

Shihai Wang MD | Jun'an Pan MD | Bei Xiao NP | Yongjiang Tang MD | Jianjun Lan MD |
Xuezhong Zheng MD | Chao Yang MD | Dawen Xu MD | Jiyu Zhang MD 

Department of Cardiovascular
Disease, Central Hospital of Panzhihua City,
Panzhihua, China

Correspondence

Dawen Xu and Jiyu Zhang, Department of
Cardiovascular Disease, Central Hospital of
Panzhihua City, Panzhihua, Sichuan, 617000,
China.
Email: pzhxdw432@sina.com (D. X.) and
1049664859@qq.com (J. Z.)

Abstract

Objectives: We sought to evaluate the safety and efficacy in improving cardiac function and functional capacity with device closure of large atrial septal defects (ASD) in senior adults.

Background: Atrial septal defect accounts for about 10% of all congenital heart disease. It still remains unclear whether large ASD closure in senior people should be performed or not. Hence we aim to prospectively assess the safety and clinical status of senior patients after transcatheter closure in large ASD.

Patients and interventions: This was a prospective study of all patients aged over 50 years who underwent device closure of a secundum large ASD between January 2013 and January 2018. Investigations including brain natriuretic peptide level, electrocardiography, chest X-ray, transthoracic echocardiogram, transesophageal echocardiogram, and 6-minute walk test were performed before and at 2 days and 4 weeks and 6 months after the procedure.

Results: Twenty patients (median age 68 years, 10 women) had transcatheter device closure of large ASD successfully. Median ASD size was 32 mm (range 30–39 mm). Median pulmonary artery pressure was 58 mm Hg (range 47–67 mm Hg). At 6 months, there was a significant change in right atrium size ($P < .001$) and right ventricle size ($P < .01$) and left ventricle size ($P < .001$) and also pulmonary artery pressure ($P < .0001$), New York Heart Association functional class improved ($P = .03$) in 19 patients and also significant improvement in 6-minute walk test distance ($P < .001$). There were no major complications.

Conclusions: Our data showed that large ASD closure at senior people results in satisfactory cardiac remodeling and cardiac function improvement.

1 | INTRODUCTION

Atrial septal defect (ASD) is one of the most common forms of congenital heart disease in adults, accounting for approximately 10% of all congenital heart disease.¹ The left-to-right shunt through an ASD results in chronic volume overload of the right heart and, if

untreated, may result in atrial arrhythmias,² right heart failure,³ pulmonary hypertension,⁴ and/or systemic embolism.⁵ Closure of ASD in children and young adults is recommended with low operative risk and a good long-term prognosis.⁶ Our institution define a large ASD if the defect size ≥ 30 mm. Adults with a large ASD, although often reporting no symptoms or only mild effort intolerance, may have a significant reduction in cardiopulmonary function during formal exercise testing.⁷ However, the benefits of large ASD closure in senior

Shihai Wang and Jun'an Pan contributed equally to this study.

people are less clear,⁸ and closure of the defect may be postponed or withheld.⁹ We therefore prospectively assessed the effects of transcatheter closure of large ASD based on clinical and echocardiographic parameters in senior people.

2 | METHODS

2.1 | Study population

We prospectively studied consecutive patients aged over 50 years who underwent device closure of a secundum large ASD at the Central Hospital of Panzhihua City, Sichuan, between January 2013 and January 2018. Patients chosen for device closure were those with a secundum large ASD defined by the presence of right heart dilation and significant left-to-right shunt on echocardiogram. The study was approved by the institutional ethics committee and patients signed informed consent before participating in the study. Crippled and polio patients unable to accomplish an exercise test and patients refused to give informed consent were excluded from the study.

2.2 | Device closure

Transcatheter large ASD closure was performed as previously described.¹⁰ The ASDO septal occluder (SHSMA Medical, Shanghai) was used in all patients. The ASDO septal occluder device was selected based on balloon size or intraprocedural echocardiographic assessment of ASD diameter as previously described.¹¹

2.3 | Study protocol

The following evaluations were performed immediately before ASD closure and at 2 days and 4 weeks and 6 months after the procedure: full blood count, serum brain natriuretic peptide¹² levels, 12-lead electrocardiogram, chest X-ray, transthoracic echocardiogram, and 6-minute walk test (6MWT).

TABLE 1 Patients characteristics

No. of patients	20
Mean age, years	68 (50-91)
Sex, M/F	10/10
Diabetes	6 (30)
Hypertension	8 (40)
Ischemic heart disease	4 (20)
Chronic renal failure	2 (10)
Hypercholesterolemia	9 (45)
Mean PA pressure	58 (47-67)
ASD size, mm	32 (30-39)
ASDO device size, mm	39 (36-44)
Procedure time, min	58 (50-99)

Note: Values are n (%), median (range), or n.

Abbreviations: ASD, atrial septal defect, ASDO, atrial defect septal occlude, PA, pulmonary artery.

Transthoracic echocardiographic studies were implemented according to the American Society of Echocardiography guidelines.¹³ PA pressure was estimated according to tricuspid regurgitation based on electrocardiograph before and after the procedure. Left and right ventricular diastolic dimensions were made in parasternal long-axis view and RV inlet measurement in the apical 4-chamber view.

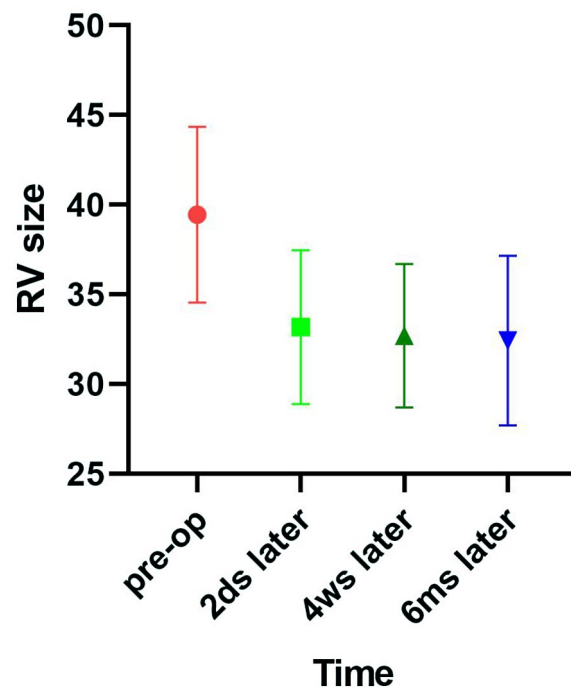


FIGURE 1 Comparison of RV size (P .001)

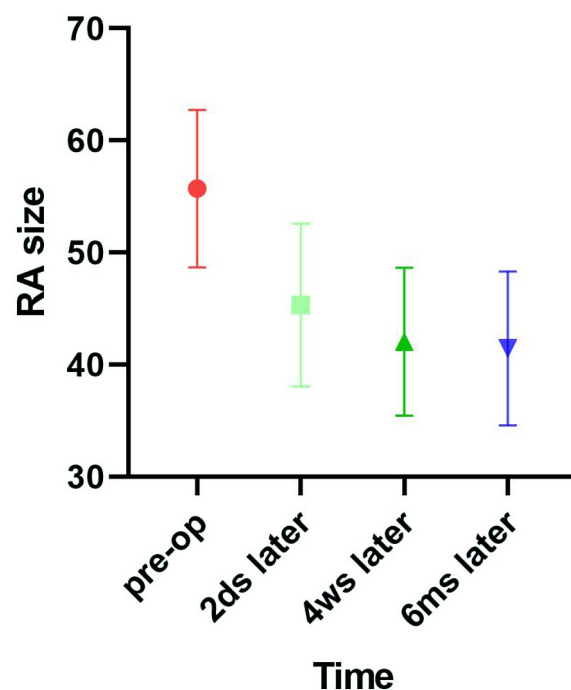


FIGURE 2 Comparison of RA size (P .001)

2.4 | Statistical analysis

GraphPad Prism 8.0 (GraphPad software Inc, California), was used for statistical calculations. Data are expressed as mean SD, or median with range, as appropriate. Changes in the continuous parameters over time were analyzed using a mixed model linear regression analysis, with patients as a random effect and time as a fixed effect. Change in functional (NYHA) class was assessed using a cumulative logit model for ordinal response. A *P* value .05 was considered statistically significant.

3 | RESULTS

A total of 20 patients (10 women; median age 68 years, range 50-91 years) underwent large ASD closure (Table 1). Median ASD

size was 32 mm (range 30-39 mm) and median device size was 39 mm (range 36-44 mm). Median pulmonary artery pressure was 58 mm Hg (range 47-67 mm Hg). No one showed signs of pulmonary hypertension at 6-month follow-up echocardiogram. Device delivery and implantation were performed successfully without procedure-related complications in all patients. One patient developed transient atrial flutter during the procedure which reverted to sinus rhythm without treatment. Four patients had minor groin hematoma at the puncture site. Owing to car accident at 4 weeks, one patient could not able to climb stairs and accomplish 6MWT.

Comparison of RV and RA dimensions are as shown in Figures 1 and 2. Right ventricular end-diastolic and inlet dimensions, as well as right atrial volume decreased significantly (*P* .001 for all). No significant change in tricuspid annular plane systolic excursion was found. There was also a significantly (*P* .0001) decrease in pulmonary artery pressure at 6 months (Figure 3).

At baseline, 12 (75%) patients were in NYHA functional class II and 8 (25%) were in NYHA class III, and average 6MWT distance was 330 m. Following ASD closure, a significant improvement in 6MWT distance (Figure 4A) was observed (140-m increase in average at 6 months [*P* .001]). This was associated with an improvement in NYHA class (*P* .03) (Figure 4B).

There was a significant increase in LV end-diastolic and end-systolic dimensions after large ASD closure (Figure 5). There was an insignificant (*P* .06) increase in LVEF (Figure 6). After an initial rise in atrial natriuretic peptide levels at 4 weeks, this decreased significantly (*P* .001) at 6 months (Figure 7).

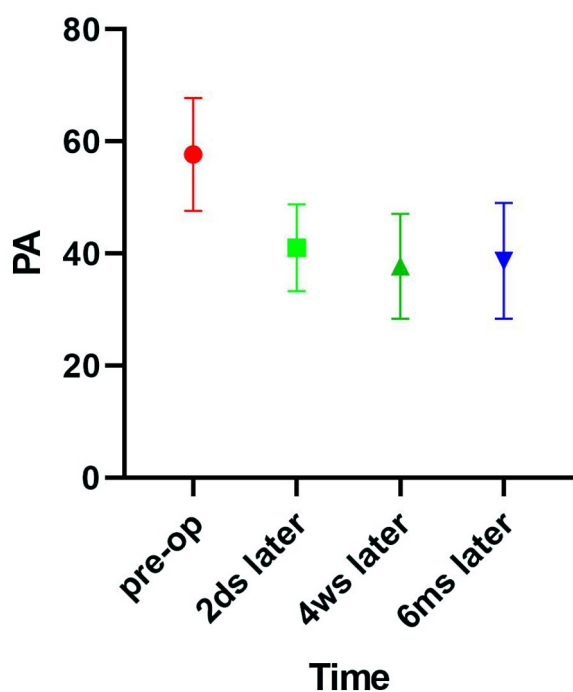


FIGURE 3 Comparison of PA pressure (*P* .0001)

4 | DISCUSSION

In this study, we have demonstrated that large ASD closure is technically feasible with a high success rate and can be performed at low risk in the senior population, which is similar to what has been reported by Se Yong Jung et al.¹⁴ We observed significant improvement in symptoms and functional ability with favorable cardiac remodeling in a senior population after the procedure. The most

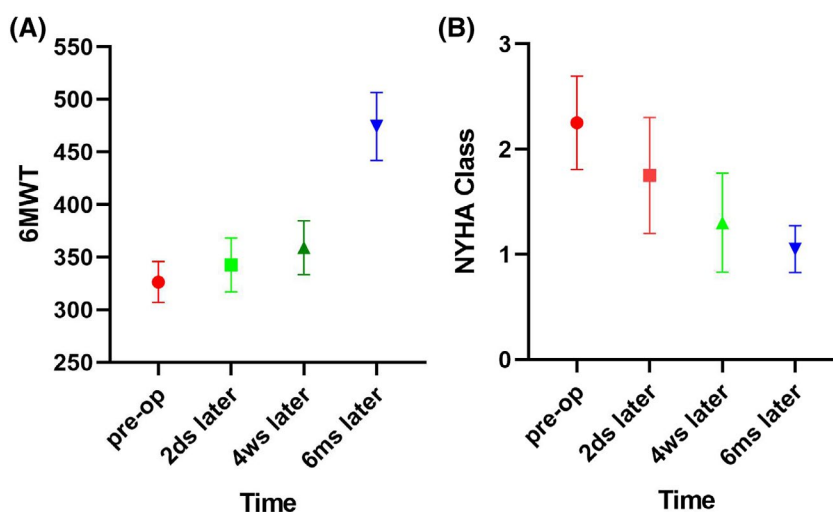


FIGURE 4 (A) Improvement in 6MWT (*P* .001). (B) Improvement in NYHA class (*P* .03)

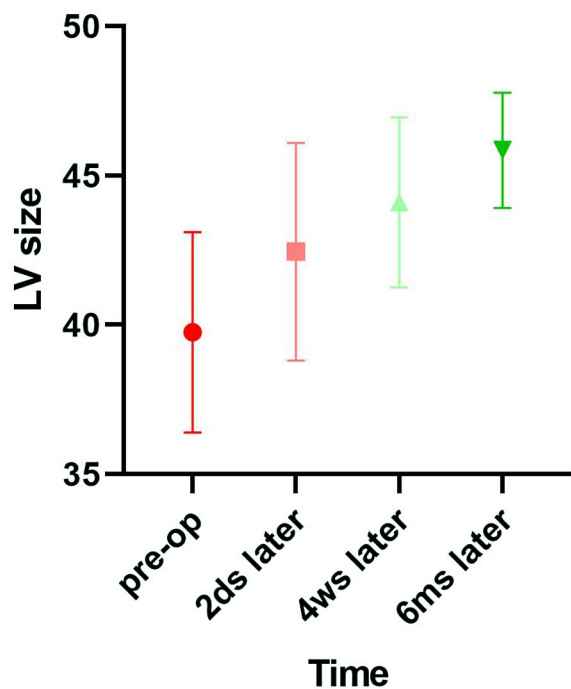


FIGURE 5 Comparison of LV size (P .001)

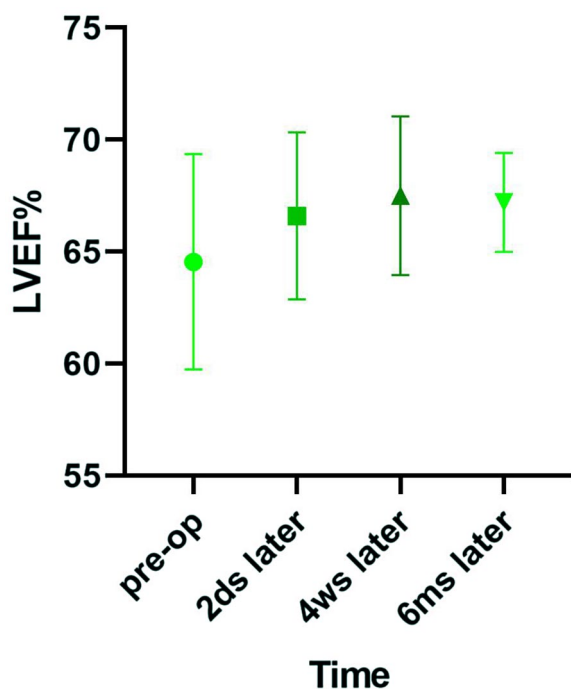


FIGURE 6 Comparison of LVEF (P .06)

clinically relevant finding of our study was the increase in exercise capacity as indicated by the 44.3% increase in 6MWT distance and NYHA functional class.

Closure of large ASD is often considered non-beneficial in senior patients because few data exist on symptomatic relief gained after device closure in senior patients. Our study provides further

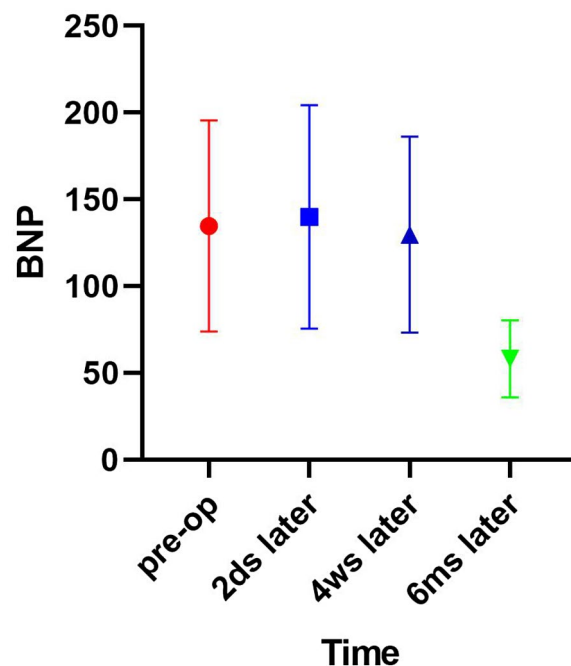


FIGURE 7 Change in BNP levels (P .001)

evidence that transcatheter device closure of large ASD in adults over the age of 50 years is not only safe and effective, but also results in symptomatic relief by improving functional class and 6MWT distance with favorable cardiac remodeling. Our study has shown significant improvement in both 6MWT distance and NYHA class after large ASD closure. The 6MWT is a simple clinical tool, which is useful in the serial evaluation of patient status.¹⁵ In highly symptomatic patients, it provides information similar to cardiopulmonary exercise testing and has an independent prognostic value.¹⁶ Similarly, NYHA functional class is also a predictor of survival in heart failure patients.¹⁷

We demonstrated that despite longstanding RV dilation from volume overloading, there is still potential for improvement in RV size and possible improvement in functions¹⁸ even at an advanced age. Closure of large ASD resulted in cardiac remodeling with a significant reversal of the right-to-left volumetric imbalance. These changes were evident within a few weeks following closure and continued at 6 months. Pascotto et al¹⁹ has shown that cardiac remodeling starts very shortly after transcatheter ASD closure in relatively young populations (mean age 22 years) and that most of the cardiac remodeling appeared within a few weeks of closure. Similarly, our senior cohort study (mean age 68 years) showed that most of the improvement in RV size took place at 2 days from large ASD closure.

Left ventricular systolic function also improved soon after closing the ASD and removing the RV volume overload. In patients with an ASD, shunting of blood into the right heart invariably affects LV filling, akin to a “steal phenomenon.” Our results support the phenomenon of ventricular interdependence²⁰ associated with RV volume overload and the “reverse Bernheim’s effect” in which the septum

bulges into the LV cavity leading to impaired LV filling. Following device closure, left-to-right shunt is abolished and LV filling is improved resulting in an increase in LV dimensions and ejection fraction. The improvement in LV function was most marked in the first 4 weeks after ASD closure, suggesting that LV remodeling occurs early and plateaus thereafter.²¹

Improvements in LV function are likely to be a major determinant of the early improvement in NYHA functional class seen after ASD closure. It is of interest that the improvement in LV size and function appears to occur earlier than in the RV. This may suggest that LV remodeling is independent of RV remodeling. Schubert et al²² have shown that ASD closure in some elderly patients may be associated with a transient increase in left atrial pressure and subsequent pulmonary edema due to an underlying "stiff" LV. However, in our cohort, no cases of pulmonary edema occurred and no significant new arrhythmias were noted during the 6 months follow-up. Similarly no patient developed signs of diastolic dysfunction or mitral regurgitation following large ASD closure.

No major adverse cardiovascular events related to the procedure were observed in the first 4 weeks after closure in our patients, which is in contrast to what has been reported for surgical ASD closure in patients 40 years of age.²³

4.1 | Study limitations

This was a non-randomized single-center cohort study, on a relatively small group of consecutive patients undergoing percutaneous large ASD closure.

4.2 | Conclusions

Our study indicate that transcatheter closure of large ASD is technically feasible and results in promising cardiac remodeling and significant improvement in functional class in senior patients.

CONFLICT OF INTEREST

None.

AUTHOR CONTRIBUTIONS

All authors have read and approved the final manuscript.

Drafted the article: S. Wang and J. Pan

Organized the article and did statistical analysis: B. Xiao

Collected the data: Y. Tang, J. Lan, X. Zheng, and C. Yang

Designed and financed the study: D. Xu and J. Zhang

ORCID

Jiyu Zhang  <https://orcid.org/0000-0002-1758-233X>

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