ISSN: 0975-3583,0976-2833 VOL15, ISSUE 09, 2024

ASSESSMENT OF RIGHT HEART FUNCTIONS AND DIMENSIONS FOLLOWING DEVICE CLOSURE OF OSTIUM SECUNDUM ATRIAL SEPTAL DEFECT

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ABSTRACT

Background: Ostium secundum atrial septal defects (OS-ASD) are among the most common congenital heart anomalies that, if left untreated, can lead to significant cardiac dysfunction due to right heart volume overload.

Methods: This prospective observational study assessed 30 patients with OS-ASD who underwent device closure at Indira Gandhi Institute of Medical Sciences, Patna. Echocardiographic measurements were collected at baseline and during follow-ups at 1 week, 1 month, 3 months, 6 months, and 12 months to evaluate changes in right heart dimensions and functions.

Results: Post-device closure, significant reductions were observed in right atrial and ventricular sizes ($p < 0.01$) and right ventricular systolic pressure ($p < 0.001$). Improvements in tricuspid annular plane systolic excursion (TAPSE) and myocardial performance index (MPI) indicated enhanced right ventricular function. These improvements were maintained throughout the 12-month follow-up period.

Conclusion: Device closure of OS-ASD significantly improves right heart dimensions and functions, offering a reliable alternative to surgical intervention. This study supports the procedure's effectiveness in correcting the hemodynamic imbalances caused by ASD and suggests durable benefits.

Keywords: Atrial Septal Defect, Device Closure, Right Heart Function, Echocardiography

ISSN: 0975-3583,0976-2833 VOL15, ISSUE 09, 2024

INTRODUCTION

Atrial septal defect (ASD), a common form of congenital heart disease, involves an opening between the left and right atria of the heart, specifically affecting the septum that divides these chambers [1]. Ostium secundum atrial septal defects (OS-ASD) represent most of these defects and can remain clinically silent or lead to significant hemodynamic complications if untreated [2].The interatrial shunt created by an ASD results in volume overload, primarily affecting the right side of the heart. This condition can lead to right atrial (RA) and right ventricular (RV) dilation, dysfunction, and eventually, pulmonary arterial hypertension and heart failure [3,4]. Device closure, a minimally invasive procedure using a transcatheter technique, has revolutionized the management of secundum ASDs, offering an alternative to open heart surgery [5]. While device closure has been shown to reduce symptoms and improve heart function, detailed assessments of right heart dimensions and functions post-closure are crucial for understanding this treatment's full benefits and potential limitations [6,7].

The primary objective of this study is to assess changes in right heart dimensions and functions following the device closure of OS-ASD. This involves evaluating the immediate and long-term effects of closure on heart structure and function, potentially guiding future therapeutic strategies and patient management.

METHODOLOGY

Study Design: This is a prospective observational study designed to assess the right heart functions and dimensions following the device closure of ostium secundum atrial septal defect (OS-ASD).

Study Setting: The study will be conducted at the Indira Gandhi Institute of Medical Sciences (IGIMS), Patna, Bihar, over a period of one year.

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Participants: The study will include a total of 30 patients diagnosed with OS-ASD, who are indicated for device closure based on current clinical guidelines. Patients will be consecutively recruited from the cardiology outpatient department (OPD) at IGIMS.

Inclusion Criteria:

- Diagnosed with ostium secundum atrial septal defect.
- Scheduled for device closure.
- Age > 12 years.

Exclusion Criteria:

- Patients with other types of ASD (e.g., sinus venosus ASD, ostium primum ASD).
- Previous heart surgery or transcatheter intervention.
- Contraindications to device closure such as inadequate septal rims or severe pulmonary hypertension.

Data Collection: Baseline characteristics, including demographic data, medical history, and specific heart-related conditions, will be collected through patient interviews and medical records review. Echocardiographic measurements will be taken to assess right heart dimensions and functions before the procedure.

Procedure: The device closure of OS-ASD will be performed using standard techniques with FDA-approved devices. The procedure will be carried out by a team of experienced cardiologists in the catheterization laboratory at IGIMS.

Follow-up and Assessments: Post-procedure follow-up will be conducted at 1 week, 1 month, 3 months, 6 months, and 12 months. At each follow-up visit, clinical evaluation and echocardiography will be performed to assess the changes in right heart dimensions and functions. The main parameters of interest include right atrial size, right ventricular size, and function (e.g., tricuspid annular plane systolic excursion [TAPSE], myocardial performance index [MPI], and right ventricular systolic pressure [RVSP]).

Statistical Analysis: Data will be analyzed using SPSS software. Descriptive statistics will be used to summarize baseline characteristics. Repeated measures ANOVA will be utilized to analyze changes over time in echocardiographic measures. A p-value of <0.05 will be considered statistically significant.

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RESULTS

The study enrolled 30 patients (21 females, 09 males) with an average age of 28.5±7.18. All patients successfully underwent device closure of OS-ASD without peri-procedural complications.

Baseline and Follow-up Echocardiographic Measurements: Echocardiographic evaluations showed significant changes in right heart dimensions and functions post-ASD closure.

- **Right Atrial Size:** There was a significant reduction in right atrial size from baseline to the 12-month follow-up (from 43.2 ± 6.4 mm to 37.5 ± 5.9 mm, $p< 0.01$).
- **Right Ventricular Size:** Right ventricular dimensions decreased significantly (from 42.8 ± 5.2 mm to 38.1 ± 4.7 mm at the base; $p< 0.01$).
- **Right Ventricular Function:**
    - **TAPSE (Tricuspid Annular Plane Systolic Excursion):** Improved from 26.23 ± 1.5 mm to 17.70 ± 1.2 mm ($p< 0.001$), indicating decrease in right ventricular volume overload.
    - **MPI (Myocardial Performance Index):** Improved from 0.59 ± 0.08 to 0.42 ± 0.06 ($p< 0.001$), suggesting better overall myocardial performance.
    - **RVSP (Right Ventricular Systolic Pressure):** Decreased from 35 ± 4.8 mmHg to 28 ± 3.6 mmHg ($p< 0.001$), reflecting reduced pulmonary arterial pressures.

Statistical Analysis: Repeated measures ANOVA confirmed significant improvements over time in RA size, RV size, TAPSE, MPI, and RVSP ($p< 0.001$ for all). These changes were consistent across follow-ups at 1 week, 1 month, 3 months, 6 months, and 12 months, indicating a sustained improvement following ASD closure.

The significant reduction in right atrial and ventricular sizes post-device closure indicates effective reduction in volume overload and normalization of cardiac geometry. Improvements

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in TAPSE and MPI suggest that right ventricular mechanical function has also benefitted from the reduction in the cardiac chamber sizes and pressures. These results are encouraging for the prognosis of patients undergoing this procedure, demonstrating substantial structural and functional cardiac benefits.

Table 1: Baseline Characteristics of Study Participants

Characteristic	**Value**
Number of Participants	30
Gender	21 females, 09 males
Average Age (years)	28.5±7.18

Table 2: Echocardiographic Measurements Over Time

Measurement	**Baseline**	**1 Week**	**1 Month**	**3 Months**	**6 Months**	**12 Months**	**p-value**
Right Atrial Size (mm)	43.2 ± 6.4	41.5 ± 6.0	40.2 ± 5.7	39.4 ± 5.6	38.3 ± 5.5	37.5 ± 5.9	<0.01
Right Ventricular Base Size (mm)	42.8 ± 5.2	41.9 ± 5.0	40.5 ± 4.9	39.7 ± 4.8	38.9 ± 4.8	38.1 ± 4.7	<0.01
TAPSE (mm)	26.23 ± 1.59	23.30 ± 1.53	21.10 ± 1.45	17.8 ± 2.2	20.73 ± 1.41	17.70 ± 1.20	<0.001
MPI	0.59 ± 0.08	0.55 ± 0.07	0.51 ± 0.07	0.47 ± 0.06	0.44 ± 0.06	0.42 ± 0.06	<0.001
RVSP (mmHg)	35 ± 4.8	34 ± 4.7	33 ± 4.6	31 ± 4.2	30 ± 3.9	28 ± 3.6	<0.001

Table 3: Repeated Measures ANOVA Results

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Measurement	F-value	p-value
Right Atrial Size	32.45	<0.001
Right Ventricular Base Size	28.79	<0.001
TAPSE	36.87	<0.001
MPI	30.22	<0.001
RVSP	26.33	<0.001

Notes:

- **TAPSE**: Tricuspid Annular Plane Systolic Excursion
- **MPI**: Myocardial Performance Index
- **RVSP**: Right Ventricular Systolic Pressure

DISCUSSION

The results of this study demonstrate significant improvements in right heart dimensions and functions following the device closure of ostium secundum atrial septal defects (OS-ASD). Notably, reductions in the sizes of the right atrium and ventricle suggest an effective alleviation of the volume overload caused by the pre-closure left-to-right shunt. This observation is consistent with previous research, which suggests that such normalization of chamber sizes can reduce the risk of arrhythmias and enhance overall cardiac function (Smith et al., 2019) [8].

Furthermore, improvement in functional indices like the tricuspid annular plane systolic excursion (TAPSE) and myocardial performance index (MPI) indicate improved right ventricular systolic function and overall cardiac performance, respectively. These improvements underscore the hypothesis that structural changes post-device closure can positively influence cardiac dynamics, thereby leading to better clinical outcomes (Jones et al., 2021) [9]. Additionally, the observed decrease in right ventricular systolic pressure (RVSP) suggests a reduction in pulmonary arterial pressures, which could potentially prevent the

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progression toward pulmonary hypertension—a common complication in untreated ASD cases (Lee and Kim, 2020) [10].

The clinical implications of these findings are significant, as they underscore the efficacy of device closure as a minimally invasive alternative to surgical closure for OS-ASD. These results suggest that timely intervention can lead to substantial cardiac remodeling, potentially preventing long-term complications associated with chronic volume overload such as heart failure and pulmonary hypertension.

However, the study is not without limitations. The sample size of 30 participants may not allow for generalization to all populations with OS-ASD, and the one-year follow-up period, while providing initial insights into post-procedural outcomes, is insufficient for understanding the long-term durability of these effects. Additionally, the absence of a control group, such as patients managed medically or through surgical closure, limits the ability to compare the efficacy of device closure against other treatment modalities.

Future research should aim to include larger, more diverse populations and extend the follow-up period to better understand the long-term outcomes of device closure for OS-ASD [11]. Comparative studies involving other therapeutic approaches, such as surgical closure, could provide deeper insights into optimal management strategies for this condition [12,13]. The positive changes observed post-device closure in this study provide compelling evidence supporting the use of this intervention for suitable candidates with OS-ASD, which could have significant implications for treatment protocols and patient outcomes in clinical practice [14,15].

CONCLUSION

The study conclusively demonstrates that device closure of ostium secundum atrial septal defects significantly improves right heart dimensions and functions. The observed reductions in right atrial and ventricular sizes, along with enhanced right ventricular systolic function as evidenced by improved TAPSE and MPI, suggest a reversal of the hemodynamic burdens imposed by ASD. Moreover, the decrease in right ventricular systolic pressure underscores the potential to avert progression towards pulmonary hypertension. These findings highlight the efficacy of device closure as a viable, minimally invasive alternative to surgical intervention for patients with OS-ASD, offering significant clinical benefits and reinforcing its role in

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current treatment strategies for this condition. Future studies should focus on long-term outcomes and comparisons with other treatment modalities to further refine patient management approaches.

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