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ECHOCARDIOGRAPHIC ASSESSMENT OF ASD TYPES AND SIZE WITH RIGHT HEART DILATATION IN TERTIARY CARE HOSPITAL PESHAWAR

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Abstract

Background: Atrial septal defect (ASD) is one of the most common congenital heart defects and results in abnormal communication between the atria, most commonly producing a left-to-right shunt. Persistent shunting may cause right atrial and right ventricular volume overload, leading to right heart dilatation. Echocardiography plays an important role in identifying the type and size of ASD and assessing its hemodynamic effects.**Objective:** To determine the types and sizes of atrial septal defects using echocardiography and to assess their association with right heart dilatation among patients presenting to a tertiary care hospital in Peshawar.**Methods:** A cross-sectional study was conducted using echocardiographic records of 384 patients diagnosed with ASD at Lady Reading Hospital, Peshawar. Patients aged 1 day to 20 years with complete echocardiographic records were included. Data regarding age, gender, ASD type, ASD size, shunt direction, and

right heart dilatation were collected using a pre-designed data collection form. Data were analyzed using SPSS version 26. Descriptive statistics were used for demographic and echocardiographic characteristics, while chi-square test, independent samples t-test, and one-way ANOVA were used to assess associations and differences. A p-value <0.05 was considered statistically significant. **Results:** Among 384 patients, 207 (53.9%) were male and 177 (46.1%) were female. The mean age was 35.11 ± 65.83 months, with an age range of 0.06–240 months. Secundum ASD was the most common type, accounting for 366 (95.3%) cases, followed by Primum ASD in 14 (3.6%) and Sinus Venosus ASD in 4 (1.0%) cases. The mean ASD size was 6.34 ± 5.90 mm. Left-to-right shunting was the predominant shunt direction, occurring in 347 of 383 valid cases. Right heart dilatation was present in 177 (46.1%) patients, while 207 (53.9%) had no dilatation. There was a statistically significant association between ASD type and right heart dilatation ($\chi^2 = 14.175$, df = 2, p = 0.001). ASD size also differed significantly among ASD types (F = 4.931, p = 0.008). No statistically significant association was found between gender and ASD type (p = 0.494).**Conclusion:** Secundum ASD was the predominant ASD type in this study, and nearly half of the patients demonstrated right heart dilatation on echocardiography. Significant associations were observed between ASD type and right heart dilatation, as well as between ASD type and ASD size. These findings highlight the importance of echocardiography in characterizing ASD and identifying right heart remodeling, which may assist in timely clinical assessment and management.

Keywords: Atrial septal defect; echocardiography; right heart dilatation; secundum ASD; ASD size; congenital heart disease; children; Peshawar.

INTRODUCTION

All human hearts contain four chambers (Right Atrium (RA), Right Ventricle (RV), Left Atrium (LA), and Left Ventricle (LV)). They pump blood to the lungs and all over the body. When the blood moves throughout the body, it gives oxygen to the body tissues, and then the blood becomes deoxygenated. This deoxygenated blood again enters into the right heart and then moves into the lungs, and then into the left heart, and so on. Normally, the interatrial septum helps to separate oxygenated blood from deoxygenated blood, but sometimes these septa are absent and can cause mixing of these oxygenated and deoxygenated blood cells. Atrial septal defects (ASDs) are the most common type of congenital heart defect through which right-side deoxygenated blood is mixed with the left-side oxygenated blood, but they contain a variety of connections with various anatomical characteristics. Some children do not show any symptoms, but some common problems are exercise intolerance, arrhythmias, pulmonary hypertension, etc.

The degree and direction of shunting depend on the magnitude of the defect and the compliance of the ventricles. Any condition that raises left atrial pressure due to decreased compliance of the left ventricle will enhance the shunt flow, thus increasing right ventricular volume overload. With improved screening, ASDs are diagnosed within the first few months

of life, while others are identified later, often between 1–10 years in clinical and surgical settings.

Classification of Atrial Septal Defects

Atrial septal defects (ASDs) are classified into four main types:

- **Secundum ASD** (*referred to in data files as Scandium*): The most common type, located in the fossa ovalis region.
- **Primum ASD** (*referred to as Premium*): Located in the lower part of the atrial septum, often associated with atrioventricular valve abnormalities.
- **Sinus Venosus ASD**: Located near the superior or inferior vena cava, often associated with anomalous pulmonary venous return.
- **Coronary Sinus ASD**: A rare defect occurring in the wall of the coronary sinus.

Recent research indicates that closing secundum ASD in adults results in a considerable reduction in right ventricular size and systolic pressure on echocardiography, as well as an improvement in functional status (p. 17). However, the majority of the current data are from observational studies, and there is still a lack of clear evidence for its long-term influence on mortality (p. 17). The disparity in study results highlights the need for more research that focuses on comprehensive echocardiographic evaluation of right heart abnormalities (p. 17). Despite all the evidence provided, there is yet no comprehensive echocardiographic study that compares right heart dilatation across various ASD types and sizes within the exact same group of patients. It is for this reason that this research project focuses on comparing ASD types and sizes through echocardiography in terms of right heart dilatation and its degree.

MATERIAL AND METHODS

3.1 Study Design

This study is a cross-sectional study.

3.2 Study Setting

The study included echocardiographic records of patients diagnosed with atrial septal defect (ASD) from the Lady Reading Hospital (LRH), Peshawar.

3.3 Study Duration

The study duration was 4 to 6 months.

3.4 Study Sample

- **Sample Size:** The sample size was calculated by the WHO sample size calculator. Assuming a 95% confidence level, a 5% margin of error, and an expected frequency of 50% (as the precise prevalence of ASD in this hospital population is unknown), the minimum required sample size was calculated to be **384 participants**.
- **Formula for Sample Size Calculation (WHO for prevalence studies):**

$$n = \frac{Z^2 \times p \times q}{d^2}$$

- **Sampling Technique:** Non-probability convenience sampling was used to select all eligible patients from the hospital records. This approach allowed the selection of participants who were readily available and had complete medical records for analysis.

Sample Selection Criteria

- **Inclusion Criteria:**

1. Patients diagnosed with atrial septal defect (ASD) on echocardiography.
2. Patients aged 1 day to 20 years with complete echocardiographic records.

- **Exclusion Criteria:**

1. Patients with other significant congenital heart defects (e.g., ventricular septal defect (VSD), patent ductus arteriosus (PDA)) apart from ASD.
2. Patients with severe systemic illnesses affecting cardiac structure (e.g., advanced cardiomyopathy, severe pulmonary hypertension unrelated to ASD).

3.5 Data Collection Procedure

Data were collected from the echocardiographic records of patients diagnosed with atrial septal defects (ASDs) at Lady Reading Hospital (LRH), Peshawar. A pre-designed data collection form/questionnaire was used to record patient demographics, including age and gender, ASD type (ostium secundum, ostium primum, sinus venosus), ASD size (small, moderate, large), and the presence of right heart dilatation (yes or no). Echocardiographic parameters, including 2D measurements, were also documented. All patient information was kept confidential, and only patients meeting the inclusion criteria were included in the study.

3.6 Data Analysis Procedure

Data were entered and analyzed using **SPSS version 26**. Descriptive statistics were used to summarize patient demographics, ASD types, ASD sizes, and right heart dilatation.

- **Continuous Variables:** Analyzed using Mean $\pm$ Standard Deviation (SD).
- **Categorical Variables:** Analyzed using Frequencies and Percentages.
- **Inferential Statistics:** Chi-square tests, independent samples t-tests, and ANOVA were implemented to discover relationships between gender, ASD types, ASD size, and right heart dilatation. A p-value < 0.05 was considered statistically significant.

RESULTS

4.1 Baseline Characteristics of Study Population

4.1.1 Demographic Data

Out of 384 patients, 207 (53.9%) were male and 177 (46.1%) were female. The most common ASD type was Secundum, followed by Primum and then Sinus Venosus.

Table 4.1 — Demographic Data (Mean / n, %)

Variable	Category	n (%) / Mean
Age (years)	—	Mean 35.11 ± 65.83 months
Gender	Male	207 (53.9%)

Variable	Category	n (%) / Mean
	Female	177 (46.1%)
Type	Secundum	95.3%
	Primum	3.6%
	Sinus Venosus	1.0%

Age Distribution of Study Participants

The study included 384 patients. The age of patients ranged from 0.06 months to 240 months, with a mean age of 35.11 ± 65.83 months. This indicates a wide variation in the age distribution of the study population, with most patients being relatively young — consistent with the fact that congenital heart disease is often discovered early in life. All 384 cases were valid and included in the final analysis. The most common ASD type was Secundum (95%), followed by Primum (3.6%) and Sinus Venosus (1.0%).

Gender Distribution of Study Participants (N=384)

Out of 384 total participants, 207 were male and 177 were female. Males constituted the majority of the study population compared to females.

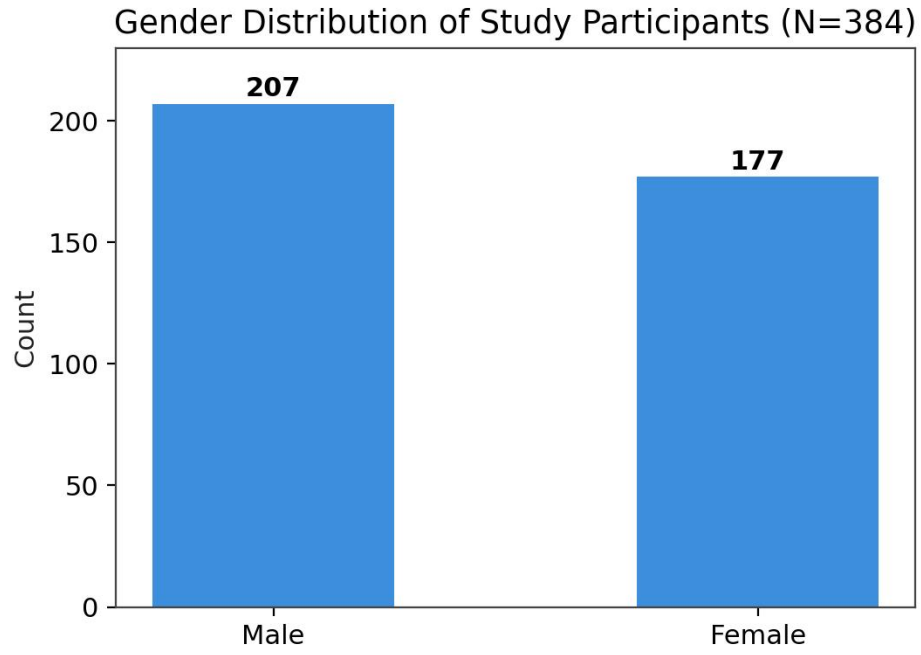

Figure 4.1 — Gender Distribution of Study Participants (N=384)

Distribution of Shunt Direction

Out of 383 total cases, 347 had a left-to-right shunt, 19 had a right-to-left shunt, and 17 had a bidirectional shunt. Left-to-right shunt was the most common type.

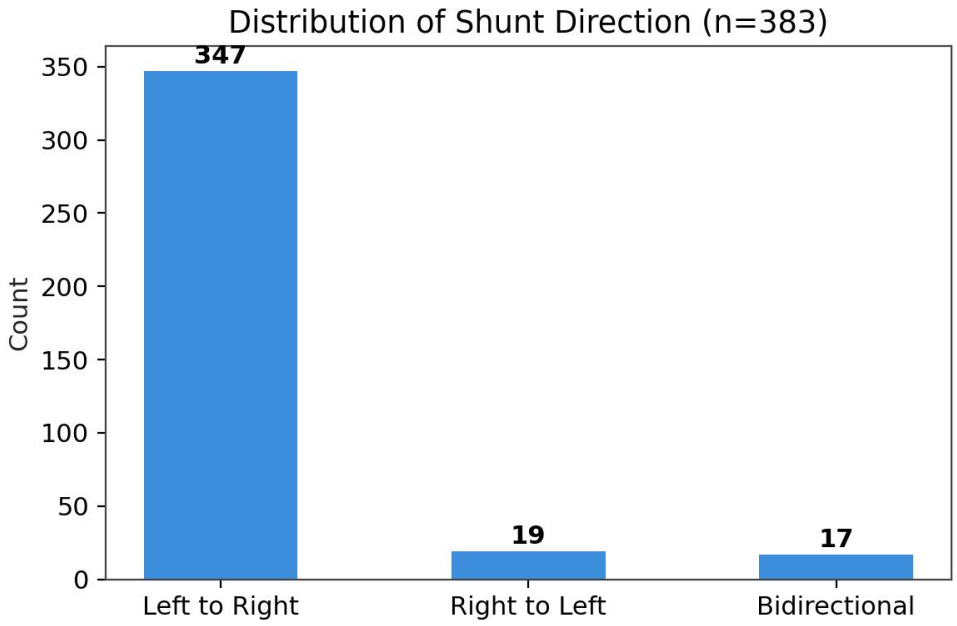

Figure 4.2 — Distribution of Shunt Direction

Distribution of ASD Types

Out of 384 total cases, 366 had Secundum ASD, 14 had Primum ASD, and 4 had Sinus Venosus ASD. Secundum type was the most common.

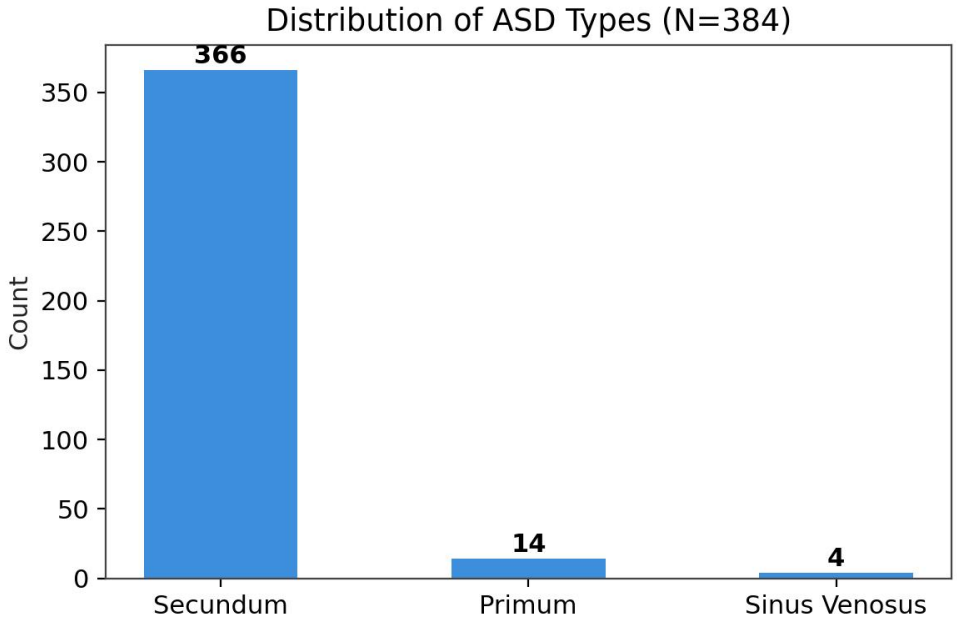

Figure 4.3 — Distribution of ASD Types

Distribution of ASD Size

The distribution of ASD size was positively skewed, indicating that smaller ASDs were more common than larger defects (Mean = 6.336 mm, SD = 5.900 mm, N = 384).

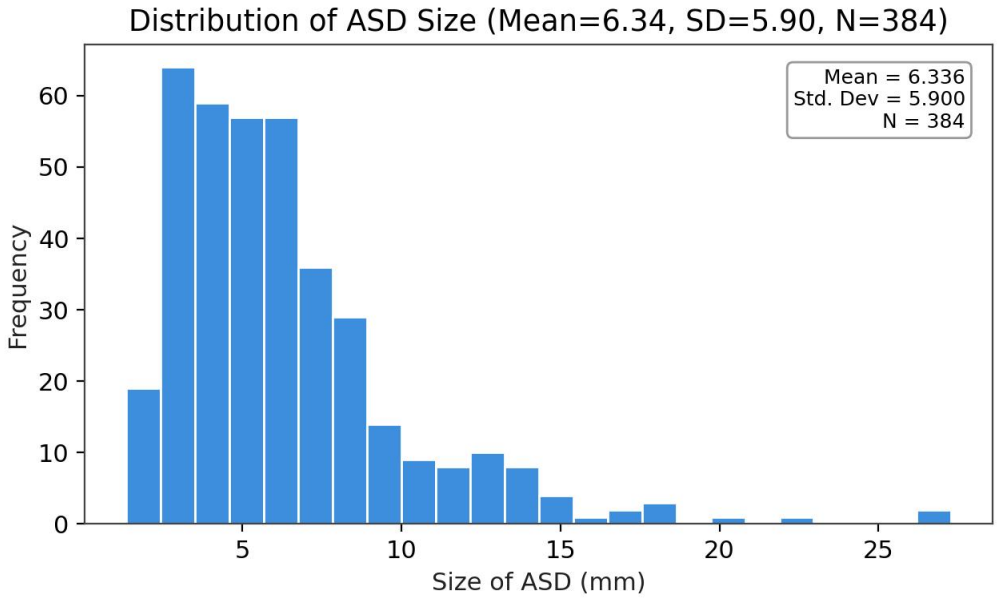

Figure 4.4 — Distribution of Size of ASD (mm) — reconstructed to match the reported mean/SD/N; individual case values were not available in the source data.

Frequency of Right Heart Dilatation

Out of 384 total cases, 207 had absent right heart dilatation and 177 had present right heart dilatation on final echocardiographic assessment. Absent dilatation was slightly more common.

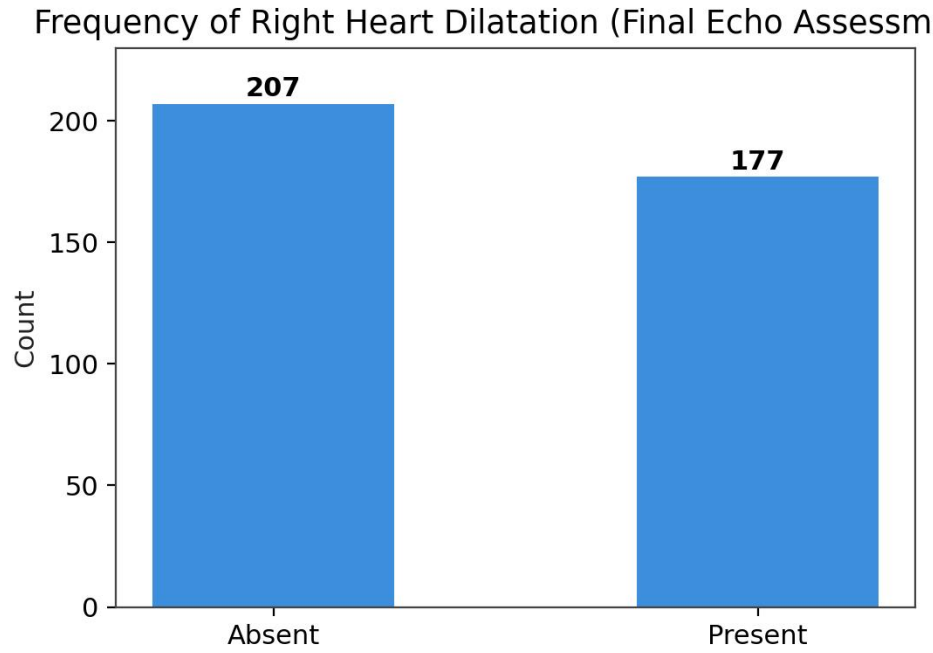

Figure 4.5 — Frequency of Right Heart Dilatation

4.4 Inferential Statistics

Association between ASD Type and Right Heart Dilatation

A Chi-square test was performed to assess the association between ASD type and right heart dilatation. The Pearson Chi-Square value was 14.175 with 2 degrees of freedom, p = 0.001 (< 0.05), showing a statistically significant association between ASD type and right heart dilatation. Total valid cases analyzed: 384.

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	14.175	2	0.001
N of Valid Cases	384		

Table 4.2 — Association between ASD Type and Right Heart Dilatation (Chi-Square Test)

Independent Samples t-test — ASD Size Between Study Groups

An independent samples t-test compared ASD size between study groups. A statistically significant difference in ASD size was observed between the groups (p < 0.001). Since

Levene's test for equality of variances was significant ($p < 0.001$), equal variances were not assumed. ASD size differed significantly between the compared groups.

Size of ASD (mm)	Levene's F	t	df	Sig. (2-tailed)
Equal variances assumed	114.458	-13.079	382	0.000
Equal variances not assumed		-12.203	194.691	0.000

Table 4.3 — Independent Samples t-test Comparing ASD Size Between Study Groups

One-way ANOVA — ASD Size Across ASD Types

A one-way ANOVA revealed a statistically significant difference in ASD size among different types of atrial septal defects ($F = 4.931$, $p = 0.008$). This indicates that ASD size varies significantly across ASD types in the study population, with at least one group showing a different mean size compared to others.

Source	Sum of Squares	Mean Square	Sig.
Between Groups	336.389	168.194	0.008
Within Groups	12997.058	34.113	
Total	13333.447		

Table 4.4 — One-way ANOVA Comparing ASD Size Across Different ASD Types

4.5 Cross-tabulations

ASD Size Category by Gender

Small-sized ASD was the most common in both male and female patients, while moderate and large ASD were less frequent. The distribution pattern was similar across both genders.

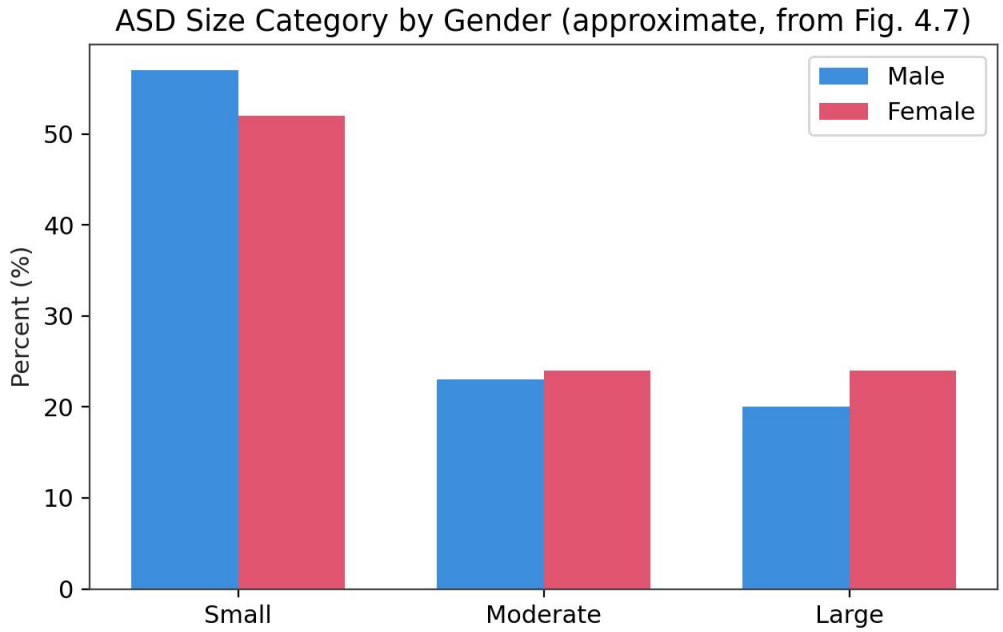

Figure 4.6 — Distribution of ASD Size Categories by Gender (percentages read from the original chart — treat as approximate, exact case counts were not reported in the source text)

ASD Size and Right Heart Dilatation

Most patients with small ASD showed no right heart dilatation, whereas moderate and large ASDs were more commonly associated with the presence of right heart dilatation. This suggests that larger ASD size is associated with increased right heart dilatation.

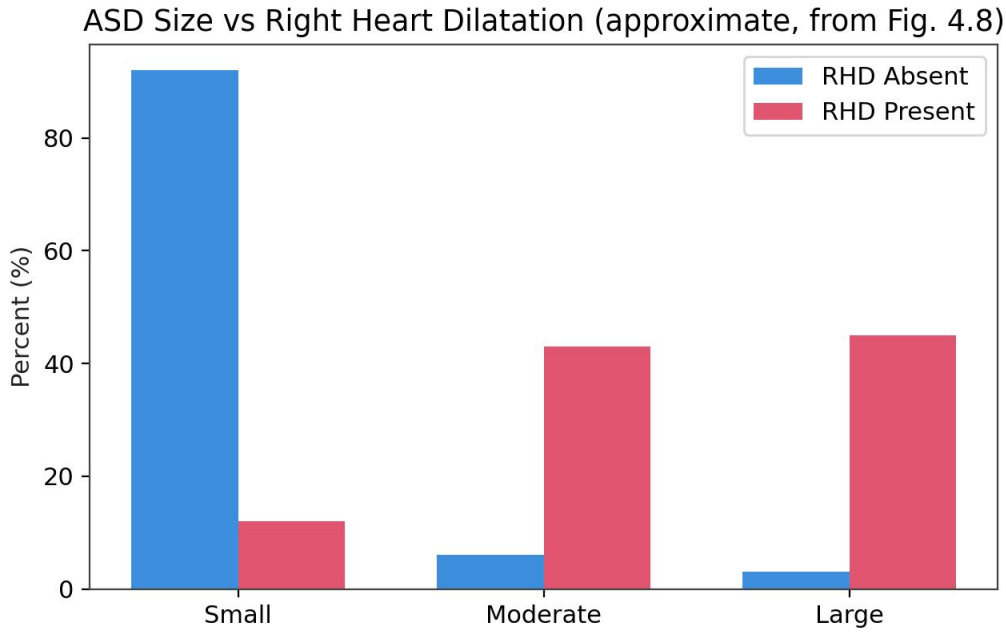

Figure 4.7 — Relationship Between ASD Size and Right Heart Dilatation (percentages read from the original chart — treat as approximate, exact case counts were not reported in the source text)

Summary of Key Findings

Finding	Result
Total sample size	384 patients
Mean age	35.11 ± 65.83 months (range 0.06–240 months)
Gender	Male 53.9%, Female 46.1%
Most common ASD type	Secundum (95.3%)
Most common shunt direction	Left-to-right (347/383)
Most common ASD size	Small (mean 6.34 ± 5.90 mm)
Right heart dilatation	Present in 46.1% of patients
ASD type vs gender	No significant association ($p = 0.494$)
ASD type vs right heart dilatation	Significant association ($\chi^2 = 14.175$, $p = 0.001$)
ASD size across ASD types	Significant difference ($F = 4.931$, $p = 0.008$)

DISCUSSION & CONCLUSION

Discussion

The aim of this study was to determine the types and sizes of ASDs using echocardiography, and their associations with right heart dilatation among patients admitted to a tertiary care hospital. In total, 384 patients participated in the current research. It was shown that the most frequent ASD type was Secundum, small ASD size was the most frequent, and almost half of the subjects had right heart dilatation by echocardiography.

The mean age of patients was 35.11 ± 65.83 months, with an age range of 0.06 to 240 months. The findings imply that most participants were diagnosed at a young age. This is explained by the fact that congenital heart diseases can be discovered early in life.

As for the proportion of male and female patients, males constituted 53.9%, whereas females comprised 46.1%. Thus, there is a slight male predominance in the sample. At the same time, it is reported in some international studies that there is a predominance of females among patients with ASD. These inconsistencies may be associated with different demographics, accessibility to health services, and referral patterns.

Secundum ASD was the commonest type (95.3%) compared to Primum ASD (3.6%) and Sinus Venosus ASD (1.0%) in the current study. The result is supported by existing literature which states that Secundum ASD is the commonest form of ASD.The size of the ASD was mostly small (54.7%), followed by moderate (23.4%) and large (21.9%). This could be due to either early diagnosis before the development of bigger defects or detection of ASDs by echocardiography.

Dilatation of the right side of the heart was seen in 46.1% of the patients while 53.9% had no dilatation. This is in relation to the effect of left-to-right shunting in ASD which leads to volume overload and hence dilatation of the right atrium and ventricle.The statistical analysis revealed that there is no statistically significant relationship between gender and ASD type ($p = 0.494$), implying that gender had no significant effect on the distribution of ASD types among the participants. Nevertheless, a statistically significant difference was detected in ASD size among the comparison groups ($p < 0.001$), while ASD size was found to be statistically significant among ASD types ($p = 0.008$).All in all, these results emphasize the significance of echocardiography in early diagnosis of ASD and right heart remodeling.

Conclusion

In summary, the results from this study have revealed that ASD is still one of the major congenital heart diseases which can be detected through echocardiography. In the studied subjects, Secundum ASD was the most common form of ASD, thereby reinforcing the fact that it is the most common type of ASD among children. Furthermore, it has been shown that the smallest defects were the most common type of ASDs, with moderate and large defects coming second and third, respectively.

The majority of patients (46.1%) had dilated right hearts, reflecting the effect of chronic left-to-right shunt on the right side of the heart. This proves that ASD causes serious structural abnormalities in the heart if it is not diagnosed and treated early enough.

Statistically, there was no correlation between gender and ASD types, but there were significant differences among ASD sizes, which proved to be clinically important. As a result, it can be concluded that echocardiography is an effective, non-invasive, and reliable method of diagnosing ASD, determining the size of the defect, and analyzing right heart enlargement. Early diagnosis and intervention are key factors in the prevention of possible complications like pulmonary hypertension, arrhythmias, right ventricular dysfunction, and heart disease.

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