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Research Article

A Retrospective Cross-Sectional Descriptive Study of Outcomes of Children with Downs Syndrome Who Underwent Cardiac Catheter Intervention for Congenital Heart Lesions

Dr Mohamed Sobh[1*], Dr. Waleed El Lithy[2], Dr. Salem Al Maskari[3], Dr khalid Al Alawi[4], Dr Abdullah Al Farqani[5]

1,2. Pediatric Cardiologist

3, 4, 5. Dr. Salem Al Maskari Consultant Pediatric Cardiology Intervention and Pediatric Cardiology

Correspondence to: Dr Mohamed Sobh, Department of pediatric cardiology, National heart center, Royal Hospital, Oman.

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ABSTRACT

Objective: *Congenital heart disease (CHD) is prevalent in children with Down syndrome (DS), affecting 50.3% of cases. This study examines the demographic and geographic distribution, outcomes, and complications of cardiac catheter interventions in DS children in Oman from 2010 to 2020. Among 807 children with DS, 55 (13.5%) underwent cardiac catheter interventions. Procedural details, outcomes, and complications were analyzed, with a median follow-up of 2.4 years.* ***Results:*** *The majority of catheter interventions involved device closures, including PDA (49%), ASD (28%), and VSD (21%). Residual defects decreased from 30.4% post-procedure to 7.1% at the last follow-up. Femoral artery thrombosis occurred in 16.5% of patients, predominantly with Amplatzer devices and was associated with prolonged hospital stays. Survival at follow-up was 98.2%, with one death (1.7%) reported. Median age and weight at intervention were 2.3 years and 10.2 kg, respectively.* ***Conclusion:*** *Cardiac catheterization in DS children demonstrates low mortality and manageable complications, with vascular issues being the most common. Improved awareness and care protocols are essential to reduce adverse events. Future studies should explore survival outcomes compared to non-DS children and assess risk factors for vascular complications.*

Abbrevations

ASD	**Atrial septal defect**
AVSD	Atrioventricular septal defect
CHD	**Congenital heart disease**
DS	**Down syndrome**
LPA	Left pulmonary artery
PDA	Patent ductus arteriosus
RPA	Right pulmonary artery
SD	standard deviation
VSD	**Ventricular septal defect**

Introduction

DS is the most common chromosomal with a range of morphological and structural birth defects. These include congenital mental disability, hypotonia, distinctive physical features, heart defects, and other systemic malformations. The incidence of CHD in children with DS is estimated to range from 40% to 50% (1). Atrioventricular septal defect (AVSD) is the most common cardiac anomaly, accounting for 45% of cases, followed by ventricular septal defect (VSD), atrial septal defect (ASD), and tetralogy of Fallot. AVSD is the most frequently reported congenital heart defect in Western literature (2,3). CHD is the leading cause of mortality and a key determinant of outcomes in children with DS. Vascular complications are the most common adverse events following cardiac catheterization in children (4).

Limited data exist regarding the outcomes of children with DS who underwent cardiac catheter intervention in Oman. Therefore, this study describes the demographic and geographic distribution of DS patients in Oman who underwent cardiac catheter intervention between 2010 and 2020. It also examines survival after cardiac catheter intervention and the incidence of complications (mainly femoral artery thrombosis).

Methods

This is a retrospective cross-sectional descriptive study. The clinical data were extracted from the Alshifa system for patients in Oman who underwent cardiac catheter intervention between 2010 and 2020. The study was approved by the ethical committee.

Statistical analysis was done using SPSS v26 (IBM Inc., Chicago, IL, USA). Quantitative variables were presented as mean and standard deviation (SD) and compared between the two groups utilizing an unpaired Student's t-test. Qualitative variables were presented as frequency and percentage (%) and were analyzed utilizing the Chi-square test or Fisher's exact test when appropriate. A two-tailed P value <0.05 was considered statistically significant and a P value <0.001 was considered highly statistically significant**.**

Results

Among the 807 children with DS, 50.3% had Congenital heart defects. Congenital heart defects were significantly more common in females (65.5%) than males (34.5%).228(56.2%) children had undergone surgical repair for an atrioventricular canal defect, 123 (30.3%) children underwent surgical procedures for congenital heart diseases other than atrioventricular septal defect (AVSD) repair and 55(13.5%) children

underwent catheter intervention (table 1,2). Additionally, 401(49.7%) had no intervention including children who had normal cardiac structures and those who experienced spontaneous closure of their congenital heart diseases. Patent foramen ovale and spontaneously closed defects were considered normal.

Table (1): Distribution of studied cases according to demographic data

Variables	**N=55**
Age (months)	
Mean ± SD	10.9 ± 5.9
Gender	**N (%)**
Male	19 (34.5%)
Female	36 (65.5%)
Weight (Kg)	
Mean ± SD	2.85 ± 1.80

Table (1): shows that the mean age of Down syndrome cases was 10.9 ± 5.9, 65.5% were female, 34.5% were males and the mean weight was 2.85 ± 1.80.

Table (2): Distribution of studied cases according to primary diagnosis

Diagnosis	**N=55**
VSD	17 (30.9%)
ASD	23 (41.8%)
PDA	31 (56.4%)
Aortopulmonary collateral	1 (1.8%)
RPA stenosis	2 (3.6%)
LPA stenosis	1 (1.8%)

Table (2): shows that the most common diagnosis was PDA (56.4%), followed by (41.8%) ASD, 30.9% VSD, 3.6% had RPA stenosis, 1.8% had Aortopulmonary collateral and 1.8% had LPA stenosis.

Table (3): Distribution of studied cases according to associated lesion

Associated lesion	**N=55**
Hypothyroidism	5 (9.1%)
Hennoch schonlein pupura	2 (3.6%)
Asthma	3 (5.5 %)
cystic hygroma	2 (3.6%)
Obesity	2 (3.6%)
cystic hygroma	2 (3.6%)
Hirschsprung	2 (3.6%)
Diaphragmatic Hernia	2 (3.6%)

Table (3): shows that the most common diagnosis was hypothyroidism (9.1%) followed by asthma (5.5%).

Out of a total of 55 patients who underwent catheter intervention. Twenty-seven children (49.1%) underwent PDA device closure, ASD device closure was Conducted in 18 children (32.7%), as well as VSD device closure was performed on 12 children (21.8 %), Additionally three children underwent Left Pulmonary Artery (LPA) stent, Right Pulmonary Artery (RPA) balloon angioplasty and Aortopulmonary collateral device closure, each with a percentage of 1.8%. Only 2 patients (3.6%) required reintervention. Also, 4 patients (7.3%) underwent device closure for two different defects (Table 4). Most of the patients 48 children (87.2%), had follow-up at our center, while the remaining received their follow-up at the nearest peripheral centers.

Table (4): Distribution of studied cases according to catheter intervention procedures

Cardiac cath procedure	**N=55**
Age at procedure (months)	
Mean ± SD	2.9 ± 5.9
Weight at procedure (Kg)	
Mean ± SD	11.09 ± 1.80

Type of procedure	**N (%)**
VSD device closure	12 (21.8%)
ASD device closure	18 (32.7%)
PDA device closure	27 (49.1%)
RPA balloon angioplasty	1 (1.8%)
Aortopulmonary collateral device closure	1 (1.8%)
LPA stent	1 (1.8%)

Table (4): shows that age at the procedure was 2.9 ± 5.9 months, weight at the procedure was 11.09 ± 1.80, 49.1% had PDA device closure, 21.8% had VSD device closure and 32.7% had ASD device closure.

17 children (30.5%) had a residual defect at 1st post-procedure Echocardiogram, but this came down in the last follow-up to 4 children (7.3%) (Figure 1). Moreover, 54 children (99.2%) were electively admitted. The median time between the last follow-up and the date of the procedure is 2.4(0.1-13.4) years. 1 patient (1.8%) passed away 8 months post-procedure due to chest infection (Table 5). Additionally, due to lower limb thrombosis, 9 of these patients (16.5%) experienced a prolonged hospital stay, mostly associated with the Amplatzer device (Figure 2).

Table (5): Distribution of studied cases according to outcome

Outcome	**N=55**
Hospital stay (days)	
Mean ± SD	3 ± 6
Outcome	**N (%)**
Survived	54 (98.2%)
Dead	1 (1.8%)
Residual lesion post-procedure	**N (%)**
Yes	17 (30.5%)

No	36 (69.5%)
Need for reintervention	**N (%)**
Yes	2 (3.6%)
No	53 (96.4%)
Echo abnormalities at the last follow-up	**N (%)**
Yes	4(7.3%)
No	47 (92.7%)

Table (5): shows that the mean of hospital stay was 3 ± 6 days, mortality rate was 1.8%, 34.5% had residual lesion, 3.6% need reintervention. While Echo abnormalities at the last follow-up were seen in only 14.5%.

Figure 1. Residual lesions post-procedural and in the last follow-up TTE

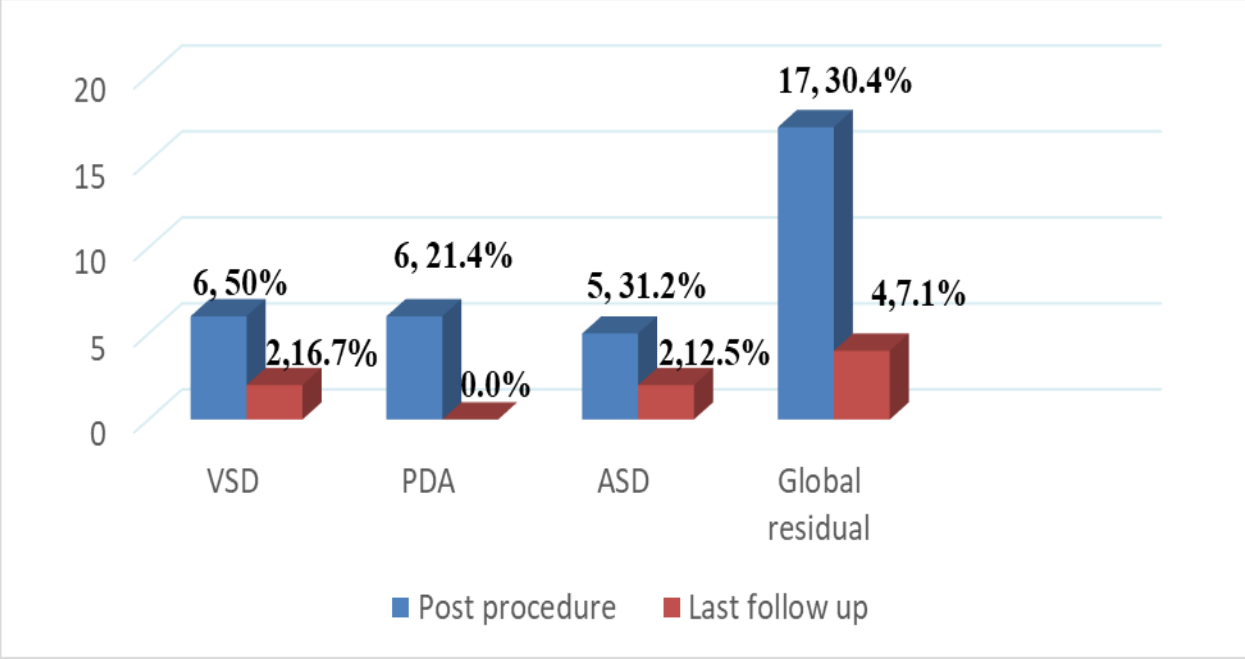
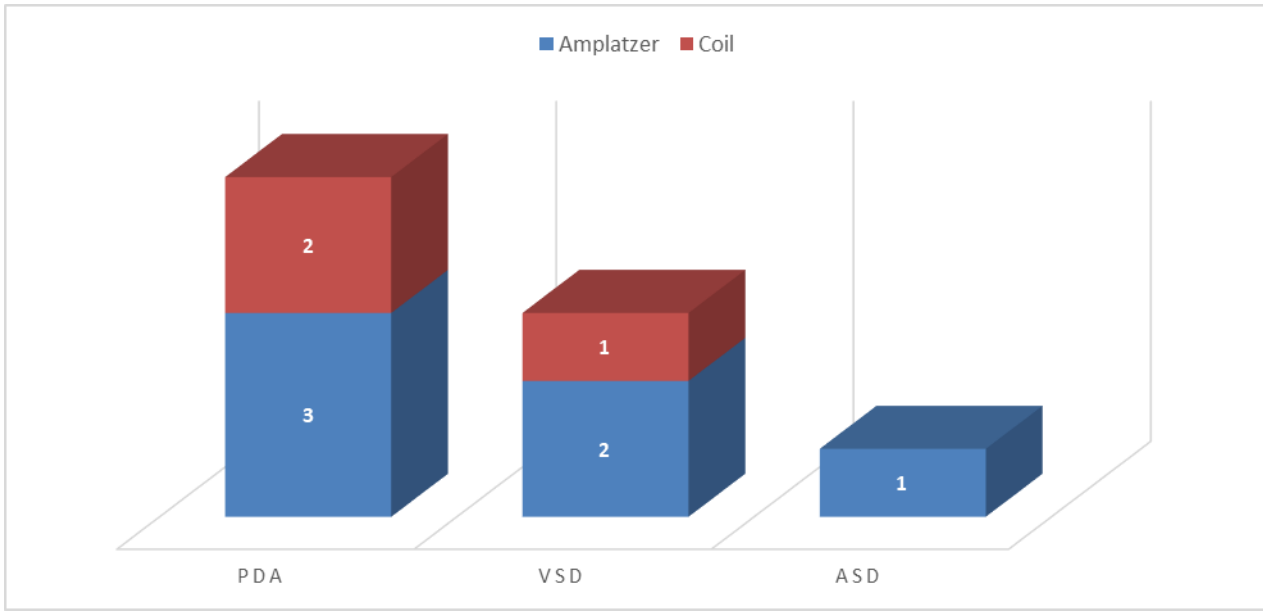


Figure 2. Lower limb thrombosis associated with cardiac defect and closure device type.



Discussion

This study assesses the incidence of complications, particularly femoral artery thrombosis, survival outcomes following cardiac catheter intervention, and the demographic and geographic distribution of DS patients in Oman who underwent the procedure between 2010 and 2020. CHD is the most prevalent structural defect observed in children diagnosed with DS, occurring in 50.3% of children with DS, consistent with the 40%-60% range reported in several studies of DS patients (5,6).

This prevalence is more pronounced in Arab countries, attributed to elevated rates of consanguineous marriage, as well as higher incidences of diabetes and obesity (7). The prevalence of CHD is higher in girls with DS (65.5%) compared to boys (34.5%), as reported by Diogenes TCP et al., 2017 and Santoro M et al., 2018(8,9).

In this study, we found that the most prevalent diagnosis among children with DS was hypothyroidism, occurring in 9.1%, followed by asthma at 5.5%. A previous study by Alkaya et al. reported a hypothyroidism prevalence of 25.3%. Congenital hypothyroidism was observed in 6 patients (1.8%) and 5 of whom had CHD (3).

DS may independently elevate the risk of thromboembolic disease in children. Vascular complications are the most frequent complication of pediatric cardiac catheterization (10). According to existing literature, the incidence rate of femoral venous thrombosis following cardiac catheterization ranges from 0% to 20% in infants and children. Similarly, the incidence rate of femoral arterial thrombosis varies between 0.8% and 40% (11).

We reported femoral artery thrombosis in 16.3% of patients (9 patients) with a median age of 6 months, consistent with findings from Kamyszek et al. (2019) and Bansal et al. (2021), which showed that patients younger than 12 months and weighing less than 10 kg were at high risk for pulse loss after catheterization. The detection rate of vascular complications increased from 8.3% to 23.4% in infants under 6 months of age following the implementation of routine post-catheterization vascular assessment using Doppler ultrasound. (12,13).

DS children with CHD had a significantly lower survival rate compared to those without CHD (14). The survival rate at one year of follow-up was 1.8%, which is lower than the rates reported by Morales-Demori et al. (2017) and Orazah Zahari et al. (2019), which indicated survival rates of 90% at one year and 80% at five years, respectively (15, 16).

Limitation

The limitations of the study include a small sample size and a heterogeneous distribution of gestational ages among the cases. Additionally, the evaluation of clinical findings related to thrombosis may show individual variations.

Conclusion

Cardiac catheterizations in children with Down syndrome (DS) can be performed with low risk. Vascular complications are the most common adverse events overall. Increased awareness of these complications has improved intensive care, which may help reduce their incidence. Future studies should compare the survival rates of children with DS who undergo cardiac catheterization to those of non-DS children with congenital heart disease (CHD) and identify risk factors for femoral thrombosis.

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