Outcomes of Congenital Heart Diseases in Duhok, Kurdistan Region of Iraq

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KEYWORDS
Congenital heart disease, surgical outcomes, Tetralogy of Fallot, Iraq, pediatric cardiology.

ABSTRACT
Background: Congenital heart diseases (CHD) are the most common birth defects worldwide, significantly impacting morbidity and mortality, especially in low- and middle-income countries where early diagnosis and access to surgical care are limited. In Iraq, congenital heart surgeries are relatively new, and few studies have investigated CHD outcomes in this context. Aim: This study aimed to evaluate the prevalence, distribution, and surgical outcomes of congenital heart diseases among patients treated at the Azadi Heart Center in Duhok, Kurdistan Region of Iraq. Patients and Methods: A retrospective, cross-sectional study was conducted involving 111 patients aged 1-69 years with CHD who underwent surgery at the Azadi Heart Center between March 2019 and March 2024. Data were collected on demographic characteristics, clinical profiles, surgical details, and postoperative complications, including mortality rates. Statistical analysis was performed using Microsoft Excel, with data presented as means, standard deviations, frequencies, and percentages. Results: The average age of patients in the study was 13 years (±16), with congenital heart disease (CHD) being most common among children, who made up 80.18% of cases. Male patients accounted for 54.95%. The most frequent CHD types observed were Tetralogy of Fallot (25%), isolated Ventricular Septal Defect (20%), and Atrial Septal Defect (10%). The surgeries were highly successful, with a 95.5% success rate. However, some patients experienced postoperative complications, such as pneumonia (11.71%), arrhythmias (10.96%), and surgical site infections (5.41%). The overall mortality rate was 10.81%, with infections being a leading cause of death after surgery. Conclusions: CHD is prevalent among young patients in Duhok, with favorable surgical outcomes and acceptable complication rates. These findings highlight the need for early detection, enhanced surgical resources, and continued surveillance to improve outcomes for CHD patients in Iraq.

1. Introduction

Congenital heart diseases (CHD) refer to structural abnormalities of the heart or major blood vessels within the chest that can have significant functional implications (1). Affecting millions of newborns, CHD is the most common birth defect worldwide. Between 1970 and 2017, the global prevalence of CHD rose by 10% every five years, reaching 8.22 per 1,000 live births. CHD results from a complex interplay of genetic and environmental factors, with environmental influences during fetal development accounting for about 10–15% of cases (2,3). Despite substantial advances in surgical and interventional techniques over recent decades, CHD remains a significant cause of illness and death among children (4). Cardiac imaging is essential for CHD diagnosis, and prenatal detection rates vary significantly in high-income countries, from below 10% to over 80%, depending on the type of defect and healthcare system. However, prenatal diagnosis through fetal echocardiography is still rare in middle- and low-income countries, even at centers performing CHD surgeries. While severe conditions like hypoplastic left heart syndrome (HLHS) are now reported less frequently, the occurrence of less severe defects, such as ventricular septal defects, atrial septal defects, and patent ductus arteriosus, has nearly tripled—likely due to advancements in early detection (5). The pattern and severity of the lesion, early detection, related abnormalities, and availability to specialized care facilities are some of the many variables that affect the prognosis of CHD. Nowadays, more than 90% of children with severe or complex congenital heart disease (CHD) survive into adulthood thanks to advancements in postoperative care, surgical management, and diagnostic technology (6,7). Clinicians have been able to monitor these children's long-term developmental improvement because of the increased survival rate over the last few decades. According to an increasing body of research, the main worry for patients with complex congenital heart disease (CHD), including those with d-transposition of the great arteries (TGA), hypoplastic left heart syndrome (HLHS), or other single-ventricle diseases, has moved from death to developmental problems. Numerous interconnected and cumulative factors, such as those unique to the disease, the treatments administered, and the characteristics of each patient, affect

the developmental outcomes for survivors with complicated congenital heart disease (8). Congenital heart disease surgeries are a relatively recent advancement in Iraq, with only a few centers performing these procedures. Among these, the Azadi Heart Center in Duhok stands out as a leading facility (9). Despite the wealth of global research on congenital heart disease (CHD), there are few in-depth studies focusing specifically on CHD in Iraq. To fill this gap, more evidence-based research is needed. This study aims to examine the prevalence, types, and outcomes of CHD cases at the Azadi Heart Center in Duhok, Iraqi Kurdistan. The results will offer valuable insights to support both academic and clinical efforts in the region.

2. Patients and methods

This study took a detailed look at patients with congenital heart disease (CHD) treated at the Azadi Heart Center in Duhok, in the Kurdistan Region of Iraq. It included 111 patients, aged between 1 and 69 years, who had surgery at the center from March 2019 to March 2024. The study followed guidelines for observational studies to ensure accuracy and reliability.

Data were collected from the patients' medical records, surgical logs, and follow-up reports. A structured survey gathered all necessary information and was divided into sections. The first section focused on basic patient details, including age, gender, body mass index (BMI), residency, and ethnicity. The second section looked at clinical background, covering the age at which CHD was diagnosed, the patient's medical and family history, and results from preoperative echocardiography, which provided information on the type of CHD as well as measurements like left ventricular ejection fraction and pulmonary artery pressure.

The third section examined the surgical details, including the type of procedure, its success, and overall outcomes. This part also documented postoperative echocardiography findings and any complications. Complications included both minor and serious issues such as bleeding, infections at the surgical site or related to devices, pneumonia, blood clots, arrhythmias, heart blocks (whether temporary or permanent), and sepsis. Additionally, information on each patient’s ICU stay and time spent on a ventilator was recorded.

Inclusion and Exclusion Criteria

The study included all patients who had undergone surgery at the Azadi Heart Center during the study period. However, patients who were lost to follow-up or those who required repeat surgeries were not part of the study. To ensure reliable results, any questionnaires missing essential information were also excluded from the final analysis.

Ethical Approval and Consent

The study protocol was approved by the Research Ethics Committee of the Executive Office of Kurdistan Board of Medical Specialties. To protect participants' privacy, their identities remained anonymous, and all data were kept confidential and used strictly for this study. Since the study was retrospective, the committee waived the requirement for informed consent.

Statistical analysis

Microsoft Excel software was used for the statistical analysis. Continous variables were calculated as mean and standard deviation. Numeric variables were descriped as frequcnies and percentages.

3. Results

The average age of the patients in the study was 13 years (±16). Congenital heart disease (CHD) was most common in children aged 1-18 years, who made up 80.18% of the patients. There was a slight male predominance, with 54.95% of patients being male and 45.05% female. Given the Azadi Heart Center’s location in Duhok, around two-thirds of the patients came from Duhok, followed by one-fifth from Mosul. A family history of CHD was found in only 8.11% of cases, and echocardiography results were normal in nearly all patients.

Table 1 summarizes the demographic and clinical characteristics of the study participants.

Table 1. Demographic characteristics of the patients

Variables	n (%)
Age (years)	
Mean (SD)	13 (±16)
1-2 years	27 (24.32)
3-5 years	25 (22.52)

6-12 years	31 (27.93)
13-18 years	6 (5.41)
19-35 years	9 (8.11)
36-50 years	9 (8.11)
51-70 years	4 (3.60)
Gender	
Female	50 (45.05)
Male	61 (54.95)
Residency	
Anbar	1 (0.90)
Duhok	78 (70.27)
Erbil	3 (2.70)
Mosul	25 (22.52)
Sulaymaniyah	3 (2.70)
Tikrit	1 (0.90)
Ethnicity	
Arabic	15 (13.51)
Christian	2 (1.80)
Kurdish	93 (83.78)
Turkman	1 (0.90)
Patients with Down syndrome	9 (8.11)
Family history of CHD	
Positive	9 (8.11)
Negative	102 (91.89)
Echo findings	
Reduced LVEF%	1 (0.90)
Pulmonary hypertension	21 (18.92)

Distribution of CHD

In this study, Tetralogy of Fallot (TOF) emerged as the most prevalent congenital anomaly, accounting for one-quarter of the cases. The second most common anomaly was isolated Ventricular Septal Defect (VSD), present in approximately one-fifth of the participants. Additionally, Atrial Septal Defect (ASD) secundum was identified in about 10% of the study population. Figure 1 illustrates the distribution of various types of congenital heart disease (CHD) among the study participants.

Surigcal characteristics, outcomes and complications

Among the total patients, 96 (86.49%) underwent full repair of the congenital anomaly, and about (10%) of patients have undergone surgery for palliative purposes. The outcome of surgery was favorable for the vast majority of the patients. Non-cardiac complications of surgeries like pneumonaia was happened among 13(11.71%). Arrhythmia and heart blocks occurred in 11(10.96%). Table 2 shows the types of surgical procedures and outcomes of surgery among the study cohort.

Table 2. Surgical type and complications (n=111)

Variables	n (%)
Type of surgical procedure	
Repair	96 (86.49)
Palliative	12 (10.81)
Repair and Palliative	3 (2.7)
Surgical outcome	
Success	106 (95.5)
Failure	5 (4.5)
Complications	
Surgical site infection	6 (5.41)
Pneumonia	13 (11.71)
Sepsis	4 (3.6)
Arrhythmia	6 (5.41)
Heart block	5 (5.55)
Pacemaker implantation	
Temporary	3 (2.7)
Permanenet	2 (1.8)

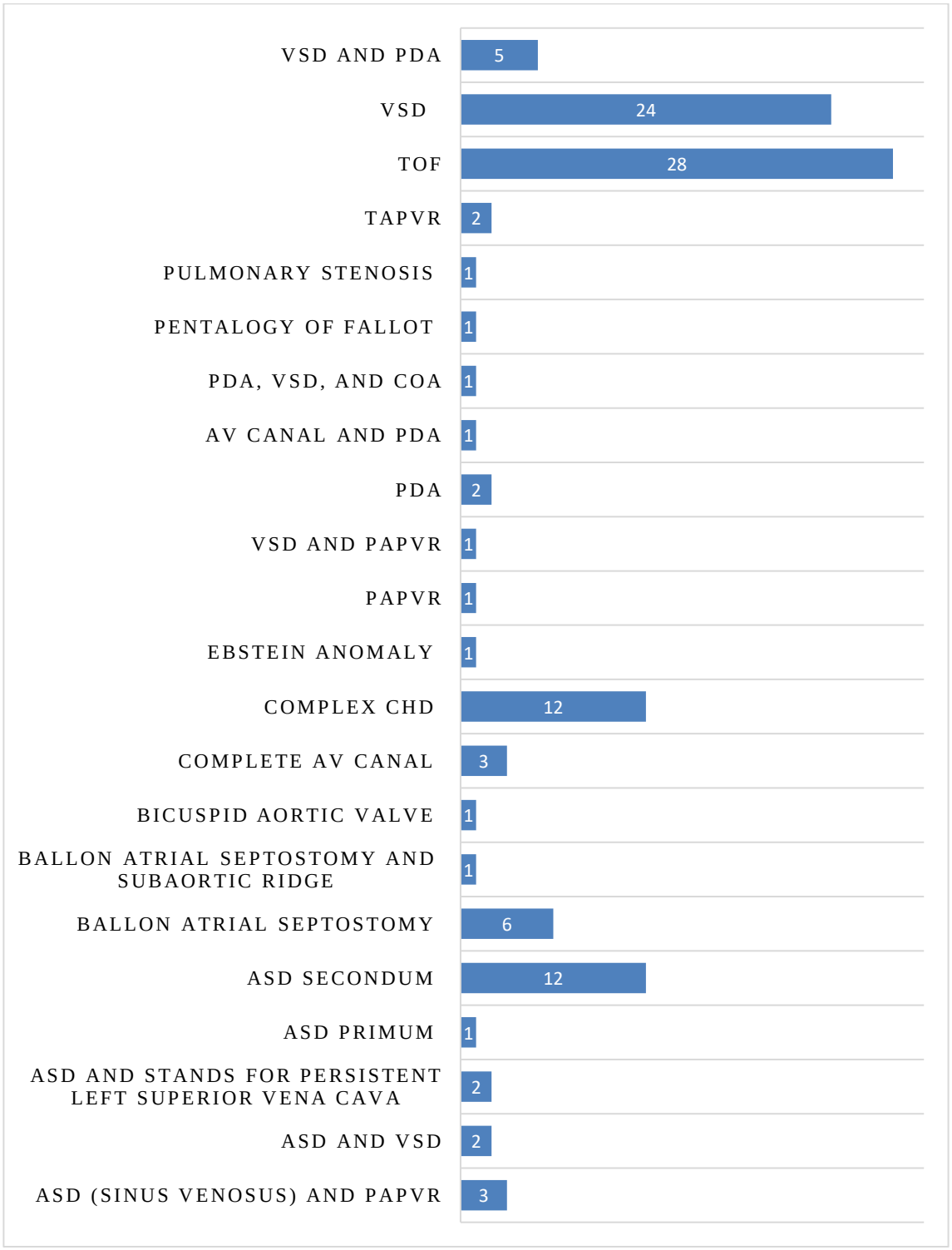

Figure 1. Types of CHD and their distribution

Mortality rates among CHD underwent surgeries

Among all cases who underwent full surgerical repair and pallative, the mortality was 12 cases (10.81%) as shown in Table 3.

Table 3. Mortality rates among CHD underwent surgery (n=111)

Variables	n (%)
Mortality	
Intraoperatively	2 (1.8)
Post-operatively	9 (8.11)

On follow-up	1 (0.90)
No mortality	99 (89.19)
Total	111 (100)

Causes of mortality

The Figure 2 illustrate the causes behind death among the 11 died cases. Infections in general, surgery by itself, stroke were the commenset causes.

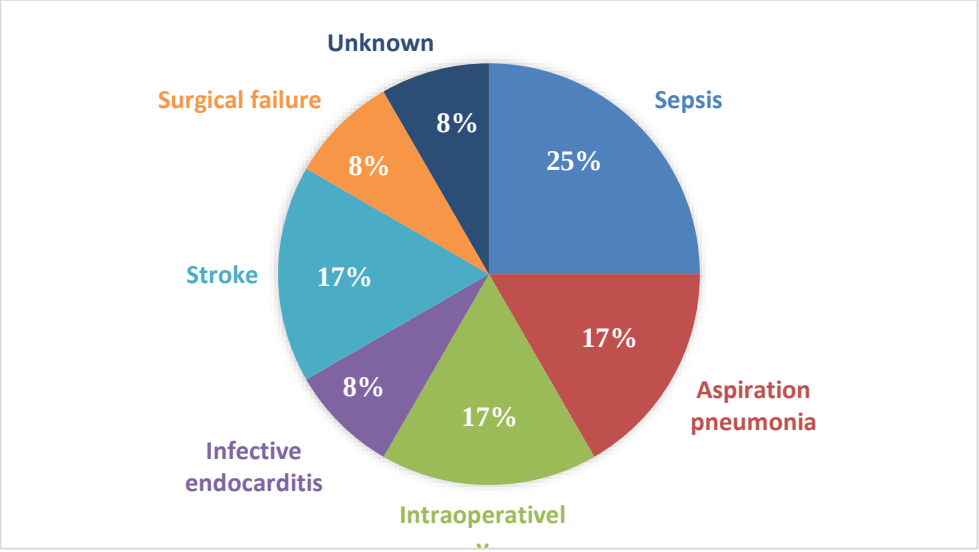

Figure 2. Causes of Death

4. Discussion

The registry's main findings highlighted that congenital heart disease (CHD) is particularly common among children in the area, with a higher incidence in males. Many cases successfully underwent full surgical repair with generally positive outcomes and an acceptable rate of complications. Among the various types of CHD, tetralogy of Fallot was the most frequently observed abnormality, followed by ventricular septal defect and atrial septal defect. Mortality rates, both short- and long-term, were around 11%, with infections being the primary factor associated with unfavorable outcomes.

Congenital heart surgery involves correcting structural heart and major blood vessel abnormalities. While these issues are often due to congenital defects, they can also arise in infants and children. CHD surgeries typically aim for either full correction to resolve a birth defect or palliative care to improve blood flow, enhance intracardiac mixing, or prepare a ventricle for later corrective surgery. In Iraq, only a few centers perform these complex procedures, with the Azadi Heart Center in Duhok being one of the few facilities offering surgeries for CHD.

The data on congenital heart disease (CHD) highlights several important trends in its demographic distribution, pointing to factors that may influence its prevalence. First, an age-wise analysis shows that CHD is most common in children aged 1-12, with a large proportion of cases occurring between 1-2 years and 6-12 years. This aligns with existing research, as CHD is typically diagnosed early in life when symptoms begin to appear during infancy or early childhood (10,11). The decrease in cases among adolescents and adults suggests that CHD primarily impacts younger age groups, possibly due to improved survival and management techniques that help reduce cases in older individuals.

In this study, a larger proportion of patients were male (60.24%) compared to female (39.76%), consistent with findings from Arnaert et al. (12), which also reported a higher prevalence of CHD in males—a pattern supported by other studies as well (13,14). In terms of cardiac function, most patients showed normal left ventricular function, though with varying levels of elevated pulmonary pressure. This finding is consistent with other studies and may reflect age-related differences in how the disease progresses and affects cardiac function. In younger children, cardiac function in CHD tends to be better preserved, likely due to adaptive mechanisms or less cumulative cardiac stress over time (14,15).

The distribution of CHD types among our cases showed higher prevalence of TOF followed by VSD and the ASD. These findings are inconsistent with previous research, such as Alaani et al (16). They found that the atrial septal defect (ASD) was the most common, followed by ventricular septal defect (VSD) and patent ductus arteriosus (PDA). This difference in the distribution can by explained by the nature of the referral cases to surgeries and the age related pattern in disease presentation. In Iran in 2008, ASD was also the most frequent defect, (17,18) but in Jordan, Saudi Arabia, Turkey, Egypt, Oman, and India, VSD was the most common (19-21). In addition, we found higher occurrence of ASD secondum among older children (>12 years) (35.71%), compared to 2.41% in children less than 12 years. Conversely, TOF was more prevalent among children, constituting 31.33% of cases, while being present in only 7.14% of older cases. Notably, complex CHD was observed in early childhood group, with a prevalence rate of 14.46%. (22-25). The interpretation of these differences in the disturbation and presentations of the CHD among cohorts and countries indicates a different exposure to the risk factors, geographical region, in addition to ages of the samples and studies design (26,27).

Several studies have investigated surgical outcomes and mortality rates in CHD underwent surgeries. The mortality rates varied depending on factors such as the type of cardiac lesion, complexity of the procedure, and patient age, associated comorbidities, surgical technique, and postoperative care as determinants of morbidity and mortality (28,29). The observed mortality rates in our study was (10.81%), align with findings from previous reports; like Zheng et al (29) who found that the neonatal period has the highest mortality rate (12.17%), followed by infant mortality (2.58%), toddler age mortality (1.16%), and preschool age mortality (0.94%), the school age and adolescent mortality rate was the lowest. In contrast to the mortality rates reported by Nasr et al (28), which remained relatively low, our study observed a higher mortality rate. These findings indicate that mortality rates can vary significantly depending on factors such as geographical location, healthcare practices, and patient populations.

The high rates of successful surgical outcomes in the study was (95.5%) are consistent with the notion that advancements in surgical techniques, perioperative care, and postoperative management have led to improved outcomes for CHD patients across all age groups. The predominance of full repair procedures, with smaller proportions undergoing palliative interventions, reflects current trends in CHD surgical management aimed at correcting underlying cardiac abnormalities whenever feasible. This approach aligns with guidelines and recommendations from organizations such as the American college of cardiology and the European society of cardiology, which emphasize the importance of individualized treatment plans based on patient age, anatomy, and disease severity.

Our findings regarding postoperative complications like the agreed studies, observed higher rates of pneumonia among the cases, possibly attributable to differences in immune function, respiratory anatomy, or underlying comorbidities (30). Additionally, the increased occurrence of arrhythmias, atrioventricular heart block and use of paceamkers in older children aligns with established literature highlighting age-related changes in cardiac electrophysiology and the greater prevalence of acquired cardiac conditions in adult populations (31, 32). And this underscore the need for close monitoring of cardiac rhythm disturbances following congenital heart surgeries across all age groups (33).

The current study indicate variations in the causes of death. Aspiration pneumonia emerged as a significant cause of mortality among younger children, consistent with prior report highlighting respiratory complications as a leading cause of morbidity and mortality in pediatric CHD patients (34). In contrast, older children (>12 years) were more commonly affected by hemorrhagic stroke and infective endocarditis, underscoring age-specific differences in the pathophysiology and clinical presentation of CHD-related complications and management of CHD-related mortality (35,36).

5. Conclusions

The findings of this study shed light on significant trends in the demographic distribution and clinical characteristics of CHD in Duhok, Iraq. Notably, CHD exhibits a notable prevalence among children aged 1-12 years, with peaks observed between ages 1-2 and 6-12 years. Gender-wise, there is a slight male predominance in CHD cases. The full repaired surgeries was the main target in the management of the cases. The morbidity and mortality rates was reasonable.

6. Recommendations

An awareness campaigns and screening programs focused on early detection of CHD among children, especially

during the critical age brackets identified in the study, for earlier intervention and improve outcomes is indicated. Given the regional disparities observed in CHD incidence, there is a need for targeted investment in healthcare infrastructure and resources in areas with high prevalence rates, such as our area, to ensure timely access to diagnosis, treatment, and surgical interventions. Besides,the contineous surveillance and research efforts are essential to monitor CHD trends over time in our area.

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