RETROSPECTIVE ANALYSIS OF CONGENITAL HEART DEFECTS AND POSTOPERATIVE COMPLICATIONS IN EARLY CHILDHOOD CARDIAC SURGERY

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Abstract. *Congenital heart defects (CHDs) are among the most common congenital anomalies in children and are associated with significant morbidity and mortality. Early surgical correction is often required to restore normal cardiac function; however, these procedures can be complicated by postoperative adverse events, including acute kidney injury (AKI), which may prolong hospitalization, increase intensive care unit (ICU) stay, and elevate in-hospital mortality. Both maternal health and prenatal conditions, such as iron deficiency anemia, infections, and obstetric complications, as well as perioperative factors, can influence the development of CHDs and impact postoperative outcomes. This retrospective study analyzed 110 children aged 6 months to 3 years who underwent cardiac surgery for CHDs. Maternal history, perioperative data, and postoperative outcomes were assessed, and patients were categorized based on the occurrence of postoperative AKI. Logistic regression analysis was performed to identify independent risk factors associated with AKI. The findings highlight that maternal and prenatal factors, including viral and TORCH infections, threatened miscarriage, and chronic urogenital infections, significantly contribute to the risk of CHDs. Perioperative factors, such as low body weight, hypotension, and prolonged surgery, were identified as independent predictors of postoperative AKI. These results underscore the importance of comprehensive evaluation of maternal history and careful perioperative management to reduce complications and improve recovery in children undergoing cardiac surgery for CHDs.*

Keywords: *congenital heart defects, pediatric cardiac surgery, maternal health, prenatal risk factors, acute kidney injury, postoperative complications***.**

Introduction

Congenital heart defects (CHDs) are the most prevalent type of congenital malformations in children and continue to be a major cause of morbidity and mortality globally. Surgical correction of CHDs in early childhood is frequently associated with perioperative and postoperative complications, including acute kidney injury (AKI), which can lead to prolonged hospitalization, extended ICU stays, and increased in-hospital mortality. Therefore, identifying factors related to CHDs and predictors of postoperative complications is essential for improving patient outcomes.

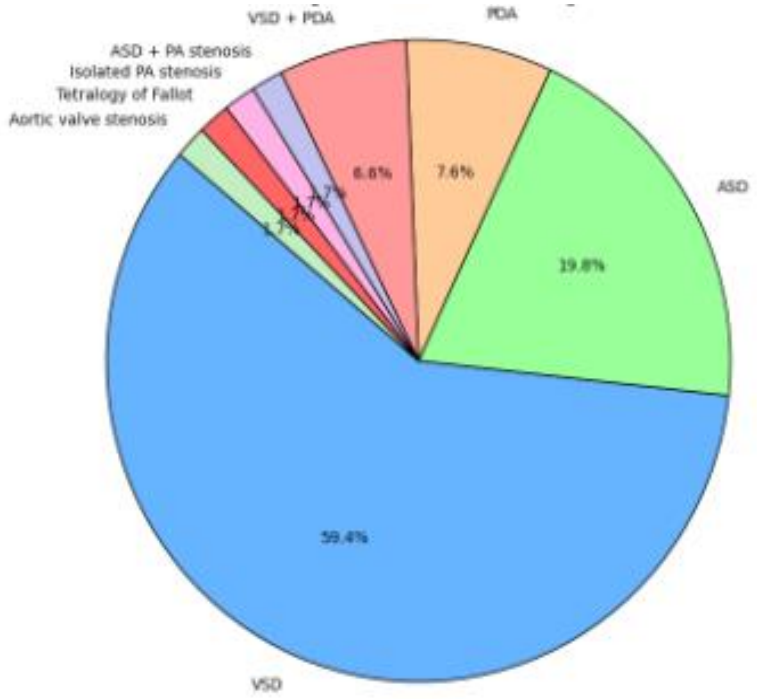
Maternal health and prenatal conditions play a critical role in the development of CHDs. Factors such as iron deficiency anemia, obstetric complications, chronic or acute infections, and metabolic disorders can adversely affect fetal cardiac development, resulting in structural anomalies such as ventricular septal defect, atrial septal defect, and Tetralogy of Fallot. Notably, infections occurring during the first trimester, including viral and TORCH infections, as well as

persistent urogenital infections, have been linked to a higher risk of CHDs in offspring. Additionally, a complicated obstetric history, including spontaneous miscarriages and threatened miscarriage, further increases this risk.

Beyond maternal and prenatal influences, perioperative factors also contribute to adverse postoperative outcomes like AKI. Low body weight, hypotension, prolonged surgical procedures, and extended cardiopulmonary bypass have been recognized as independent risk factors for the development of AKI in pediatric patients undergoing cardiac surgery. Despite improvements in surgical techniques and perioperative management, postoperative AKI remains a frequent and serious complication, highlighting the importance of thorough evaluation of both maternal history and preoperative risk factors to optimize surgical outcomes. This study aims to examine clinical, maternal, and perioperative factors and to identify independent predictors of postoperative AKI in children undergoing cardiac surgery for CHDs in early childhood. Study objective. The aim of this study was to analyze the clinical characteristics, perioperative factors, and maternal history associated with congenital heart defects in children, and to identify independent risk factors for the development of postoperative acute kidney injury (AKI) following cardiac surgery in early childhood.

Picture No.1

Distribution of congenital heart defects among 110 children



Materials and methods. A retrospective analysis of medical records was conducted in the Department of Pediatric Cardiac Surgery at the Specialized Scientific and Practical Medical Center of Cardiology and Cardiac Surgery of the Aral Region. The study included 110 children with congenital heart defects who underwent surgical interventions between 2022 and 2025. The patients' ages ranged from 6 months to 3 years, with a mean age of 21 ± 8.7 months. Of these, 57 children (63.3%) were boys and 53 (36.7%) were girls. In this study, particular attention was paid to maternal history, including complaints, occupational hazards, and the presence of chronic diseases (age at disease onset, duration, and medication use), as well as gynecological history

(previous illnesses, outcomes of prior pregnancies, course of the current pregnancy, gestosis, medication use during the current pregnancy, and details of the current delivery).

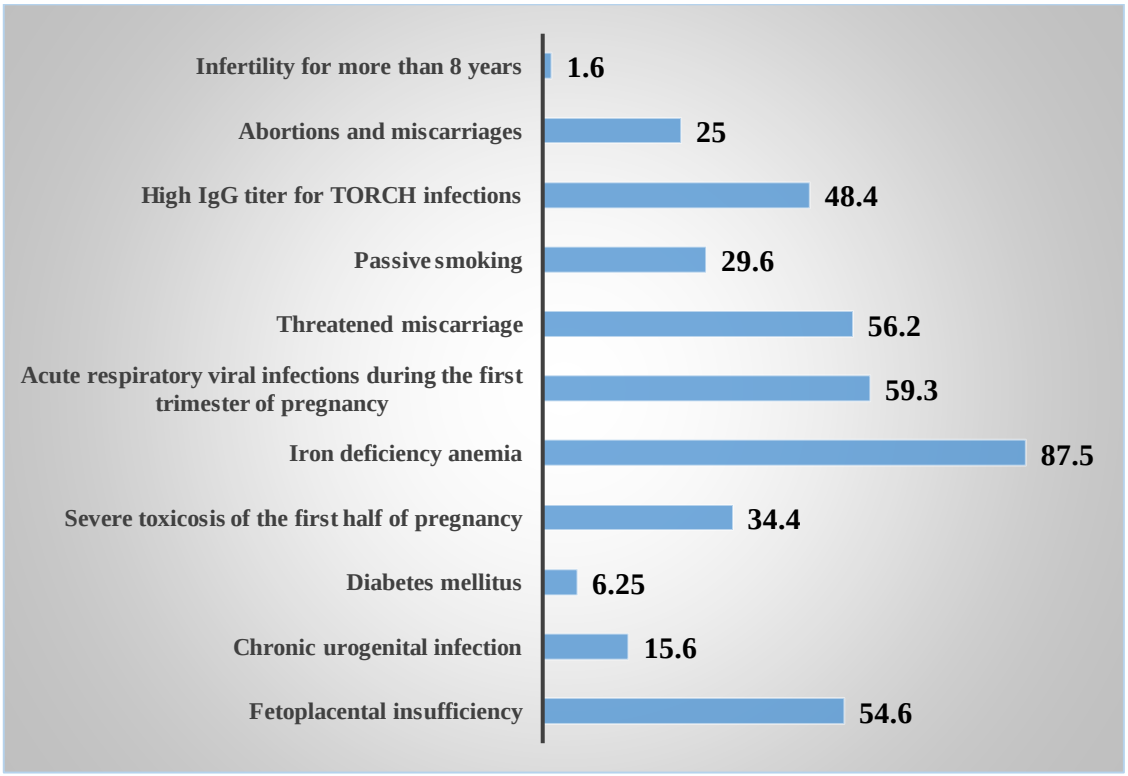
The use of mechanical ventilation during surgery was also recorded. Patients were divided into two groups based on the occurrence of postoperative acute kidney injury (AKI): the AKI group (n = 90) and the non-AKI group (n = 20). Clinical data were compared between the two groups, including demographic characteristics (sex, age, weight), preoperative, intraoperative, and postoperative parameters, duration of mechanical ventilation, length of hospital stay and intensive care unit (ICU) admission, treatment costs, and in-hospital mortality. Logistic regression analysis was performed to identify risk factors for postoperative AKI.

Results and Discussion. During the period 2022–2025 in the Khorezm region of the Republic of Uzbekistan, among 110 children who underwent surgery for congenital heart defects, ventricular septal defect (VSD) was identified in 63 children (57.3%). Atrial septal defect (ASD) was diagnosed in 21 children (19.1%), and patent ductus arteriosus (PDA) in 8 children (7.3%). A combination of VSD and PDA was found in 7 children (6.4%). The least common defects included ASD with pulmonary artery stenosis, isolated pulmonary artery stenosis, Tetralogy of Fallot, and aortic valve stenosis, each accounting for 1.6% of cases (pic.1).

During the analysis of maternal anamnesis data of children born with congenital heart defects, factors were identified that may have influenced the development of anatomical abnormalities of the cardiac structures during the intrauterine period (Figure 2).

Figure 2.

Characteristics of the maternal medical history of children born with congenital heart defects (%)



According to the data presented, the majority of mothers (87.5%) experienced the current pregnancy against the background of iron deficiency anemia, which is known to cause chronic hypoxia and fetal growth restriction. A complicated obstetric history, including spontaneous miscarriages and abortions, was noted in 25% of mothers, threats of miscarriage in early gestation

in 56.2%, and fetoplacental insufficiency in 54.6%. Previous studies have demonstrated that a history of early spontaneous miscarriages increases the risk of congenital heart defects in the fetus, such as Tetralogy of Fallot by 1.5-fold and atrial septal defect by 2-fold. Additionally, 59.3% of expectant mothers suffered from acute viral infections during the first trimester, and 48.4% showed high IgG titers against TORCH infections (herpes, toxoplasmosis, cytomegalovirus) according to enzyme-linked immunosorbent assay results. It has been established that bacterial and viral infections accompanied by fever during the first trimester increase the risk of congenital heart defects in the fetus by 2–3 times, with the most common defects being ventricular septal defect, aortic coarctation, and pulmonary valve anomalies. Persistent opportunistic and viral infections in the mother have also been identified as significant risk factors for the development of congenital heart defects in children, with herpes and cytomegalovirus infections most frequently causing malformations of the primary and secondary atrial septa during embryonic development.

Previous studies have demonstrated a link between chronic maternal urogenital infections and the risk of congenital heart defects in offspring involving obstruction of the right heart chambers [7]. In our study, 15.6% of mothers had persistent urogenital infections during pregnancy. To assess the significance of these associations, logistic regression analysis was performed. The calculation of odds ratios allowed the identification of the most significant risk factors for the development of congenital heart defects in children, as presented in Table 1.

Table 1.

Factors associated with the development of congenital heart defects in children

Factor	**OR**	**95% CI**	**p-value**
Threatened miscarriage	2.54	1.10–5.88	0.029
High IgG titer for TORCH infections	3.63	1.92–6.87	0.0001
Fetoplacental insufficiency	1.17	1.10–1.25	0.0001
Severe toxicosis in the first half of pregnancy	2.46	1.01–5.97	0.001
Chronic urogenital infection	3.21	1.84–6.25	0.031
Maternal diabetes mellitus	1.16	1.06–1.26	0.0001
Acute respiratory viral infections in the first trimester	4.37	1.35–14.11	0.0001

Note: OR – odds ratio; CI – confidence interval; p – statistical significance

As shown in Table 1, the development of anatomical abnormalities of cardiac structures during the intrauterine period is strongly associated with maternal history characteristics in children with congenital heart defects. According to logistic regression analysis, the most significant risk factors were acute respiratory viral infections in the first trimester of pregnancy (OR 4.37; 95% CI 1.35–14.11), high IgG titers for TORCH infections (OR 3.63; 95% CI 1.92–6.87), and threatened miscarriage (OR 2.54; 95% CI 1.10–5.88).

Compared to the non-AKI group, children in the AKI group had lower body weight [(7.2 ± 4.3) kg vs. (10.9 ± 2.6) kg, P = 0.025] and mean arterial pressure (MAP) [(90.3 ± 20.1 mmHg vs. 110.2 ± 15.6 mmHg, P < 0.001], but longer durations of surgery [(250.3 ± 78.8 min vs. 150.1 ± 54.2 min, P < 0.001], cardiopulmonary bypass [(201.2 ± 49.9 min vs. 70 ± 29.2 min, P < 0.001], and mechanical ventilation. The AKI group also exhibited prolonged mechanical ventilation, longer stays in the intensive care unit, extended hospitalization, and higher in-hospital mortality. Multivariate logistic regression analysis identified lower body weight (OR = 0.589, 95% CI: 0.398–0.802, P = 0.005), lower mean arterial pressure (OR = 0.829, 95% CI: 0.791–0.969, P =

0.001), and longer surgical duration (OR = 3.035, 95% CI: 2.016–1.054, P < 0.001) as independent risk factors for the development of acute kidney injury (AKI).

Conclusion

The study demonstrates that the development of congenital heart defects in children is strongly associated with maternal factors, including iron deficiency anemia, obstetric complications, TORCH infections, acute respiratory viral infections in the first trimester, and chronic urogenital infections. Logistic regression analysis identified acute respiratory viral infections, high maternal IgG titers for TORCH infections, and threatened miscarriage as the most significant risk factors for congenital heart defects. Furthermore, postoperative AKI in children was significantly associated with lower body weight, lower mean arterial pressure, and longer surgical duration. These findings highlight the importance of comprehensive maternal and perioperative assessment to identify high-risk patients and implement strategies aimed at reducing postoperative complications and improving outcomes in pediatric cardiac surgery.

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