Poplata, I. (2024). The importance of ultrasonography in the detection of congenital heart diseases in children, *MEDIS - Medical Science and Research, 3*(2), 13-17.
doi: 10.35120/medisij030213p UDK: 616.12-053.1-073.432.19

THE IMPORTANCE OF ULTRASONOGRAPHY IN THE DETECTION OF CONGENITAL HEART DISEASES IN CHILDREN

Indira Poplata[1], Elvedina Hodžić[1], Nedim Begić[1], Ljiljana Stijepović[2]*

[1]Pediatric clinic, Clinical Centre University of Sarajevo, Faculty of Healt Studies, University of Sarajevo, Sarajevo, Bosnia and Herzegovina,
e-mail: poplataindira@hotmail.com, elvedinahodzic@hotmail.com, nedim_begic91@hotmail.com
[2]Special Hospital „ Vaso Ćuković“, Risan, Risan, Montenegro, e-mail: lacmanovicljiljana@gmail.com

Abstract: Over the last few years, remarkable progress has been made in the field of congenital heart diseases. Improvements considering diagnostic modalities, especially imaging, in surgical and interventional techniques, as well as in postoperative therapy and care, have contributed to a significant reduction in mortality and morbidity. One of the most important applications of medical imaging techniques in children is the detection and treatment of congenital heart anomalies.

Objective of this article is to show the importance of ultrasonography in the detection of congenital heart diseases in children. The study was conducted on children with simple and complex congenital heart diseases and was conducted on the Pediatric Clinic, UKCS. The research is descriptive on a representative sample.

In our study, 166 children were observed, of which 148 children (77 boys, 71 girls) with simple congenital heart diseases, and 18 children (8 boys, 10 girls) with complex congenital heart diseases. Out of the total number of observed children, 115 had a surgical correction, 97 children with simple congenital heart diseases (45 boys, 52 girls) and 18 children with complex congenital heart diseases (8 boys, 10 girls). The number of children monitored through the Cardiac Counseling Center who didn't undergo surgical correction was 51, all with simple congenital heart diseases. Out of the total number of observed children who were frequently coming for follow-ups, 28 children had changes on the ECG, and 138 of them had no changes on the ECG, 93 were surgically treated, and 73 of them were on conservative therapy.

Based on the results of the research, we conclude that ultrasonography is an important method in the detection and treatment of congenital heart diseases.

Keywords: ultrasonography, ultrasound, congenital heart diseases, children, diagnostics.

Field: Pediatric cardiology.

1. INTRODUCTION

Ultrasonography is a non-invasive diagnostic method, based on the use of ultrasound waves. Ultrasound waves are waves of frequency above the audible frequency of the human ear. Ultrasound with a frequency between 3 and 10 MHz is being used in medical diagnostics. In the body, ultrasound is primarily propagated by longitudinal waves, in which tissue particles vibrate along the direction of wave propagation. Today's medical ultrasound devices use information about the time and direction of ultrasound return and the amplitude of reflected ultrasound from tissues and organs. (1)

Until the introduction of ultrasound in practice in 1961, fetal diseases, including hereditary ones, were diagnosed only after birth. With the use of ultrasound, obstetrics is given the opportunity to study the growth and development of the fetus and to detect fetal anomalies. (2) The ultrasound enables the morphology of the fetus to be examined during early gestation, while directly, also with the help of ultrasound, various fetal cells, tissues and fluids can be taken for examination without great danger to the fetus and mother (3).

Detection of fetal malformations in the early period significantly reduces the birth of children with congenital heart diseases (CHD), and thus the rate of perinatal morbidity and mortality. (4)

Certain disorders of early embryonic development can be observed as early as the first trimester of pregnancy using transvaginal ultrasonography. Targeted ultrasound examination in the second trimester of pregnancy is very useful in detecting congenital fetal anomalies. Fetal echocardiography is of great importance as a complementary selection technique, because a large proportion of fetuses with anomalies have an associated cardiac anomaly. (5)

CHD are etiologically and phenotypically different groups of diseases that are of great public health importance primarily due to the frequency, but also due to the fact that, because of advances in diagnostic methods, development of fetal and pediatric cardiology, better supportive therapy, improved

*Corresponding author: poplataindira@hotmail.com

cardiac surgery and procedures, better connectivity and the cooperation of leading centers and advances in medicine in general, a large number of children reach adulthood, although most of them remain chronic patients who need to be monitored.

CHD are the leading cause of newborn, infant and young child mortality, and are a growing public health problem. This is a group of childhood diseases that pass into adulthood. (6)

The incidence of CHD is about 7-8/1000 live births and is the most common cause of death in the perinatal and early neonatal period. The incidence of complex and significant cardiac anomalies requiring intensive care, interventional treatment and/or cardiac surgery is about 3-4/1000 pregnancies and they can be prenatally diagnosed by ultrasound examination of the fetal heart. The purpose of fetal echocardiography is to detect CHD during intrauterine life and timely preparation for childbirth and treatment. (7)

Depending on the external manifestations of the pathology, the following types of CHD are distinguished: “Simple” CHD and “Complex” CHD.

Depending on the nature of circulatory disorders, CHD in children are classified into the following types: 1. CHD with left-right shunt (VSD-ventricular septal defect, ASD-atrial septal defect, PDA-persistent ductus arteriosus, AVSD-atrioventricular septal defect); 2. CHD with right-left shunt (ToF- Tetralogia fallot, TGA - transposition of the great arteries, Tr.Art.- Truncus arteriosus, TAPVU- total anomalous pulmonary venous inflow); 3. Obstructive CHD (PS- pulmonary stenosis, AS- aortic stenosis, CoA- aortic coarctation).

Ultrasonography is an indispensable tool in the diagnosis and treatment of CHD in newborns, infants, children and young adolescents. The aim of ultrasonography is to determine the anatomy of the heart, including the identification of all cavities, valves, their connections, analyzing individual components and detecting abnormalities such as septal defects - monitoring normal flow through valves and detecting abnormal flow. During the examination and monitoring of patients, the pediatric cardiology nurse has an active participation in educational work with parents on how to control children with the addition of a manual, a detailed explanation of the type of CHD. (8)

Aim of the study is to determine the frequency of CHD in children aged 0 to 18 years, analyze the number of children with CHD who have been treated surgically, analyze how pediatric follow-up examinations help monitor children with CHD and to determine the role of ultrasonography in children without CHD who are involved in sports.

2. MATERIAL AND METHODS

The material for inclusion in the study was divided into five groups: 1. Children with simple CHD; 2. Children with complex CHD; 3. Children with CHD who have been treated surgically; 4. Children with CHD who are monitored through Cardiac Counseling; 5. Children who do not have CHD, who play sports, and who have undergone ultrasonography.

All patients underwent ultrasound examination on an ultrasound machine Vivid S5 with a convex probe with a diameter of 3 MHz with standard echocardiographic methods which include: (m-MOD, 2D and Doppler).

3. RESULTS

Table 1. Children with simple and complex CHD

Age	Sex	Simplex CHD	Complex CHD	Total
0-1 month	M F	2 (1,2%) /	/ /	2 (1,2%) /
2-12 months	M F	21(12,65%) 25(5,06%)	1(0,6%) 1(0,6%)	22(13,25%) 26(15,66%)
2-3 years	M F	34(20,48%) 25(15,06%)	7(4,22%) 4(2,41%)	41(24,7%) 29(17,47%)
4-6 years	M F	17(10,24%) 15(9,04%)	/ 4(2,4%)	19(11,45%) 3(1,81%)
7-12 years	M F	3(1,81%) 6(3,61%)	/ 1(0.61%)	3(1,81%) 7(4,22%)
13-18 years	M F	/ /	/ /	/ /

Source: Authors research

The total number of children with CHD in the observed period was 166 children. There were 148 children with simple CHD and 18 children with complex CHD.

Table 2. Children with simple and complex CHD who were treated surgically

Age	Sex	Simplex CHD	Complex CHD	Total
0-1 month	M F	/ /	/ /	/ /
2-12 months	M F	1(0,87%) 10(8,69%)	1(0,87%) 1(0,87%)	2(1,74%) 11(9,56%)
2-3 years	M F	24(20,87%) 21(18,26%)	7(6,08%) 4(3,48%)	31(26,96%) 25(21,74%)
4-6 years	M F	17(14,78%) 15(13,04%)	/ 4(13,48%)	17(14,78%) 19(16,52%)
7-12 years	M F	3(2,61%) 6(5,22%)	/ 1(0,87%)	3(2,61%) 7(6,08%)
13-18 years	M F	/ /	/ /	/ /

Source: Authors research

The total number of children with simple and complex CHD in the observed period who were surgically treated was 115 children, of which 97 children with simple CHD and 18 children with complex CHD. Most of the children who uderwent surgical correction were between the ages of one and three.

Table 3. Children with simple and complex CHD who didn't have a surgical correction

Age	Sex	Simplex CHD	Complex CHD	Total
0-1 month	M F	2 (3,92%) /	/ /	2 (3,92%) /
2-12 months	M F	20(39,21%) 15(29,41%)	/ /	20(39,21%) 15(29,41%)
2-3 years	M F	10(19,61%) 4(7,84%)	/ /	10(19,61%) 4(7,84%)
4-6 years	M F	/ /	/ /	/ /
7-12 years	M F	/ /	/ /	/ /
13-18 years	M F	/ /	/ /	/ /

Source: Authors research

The total number of children with CHD in the observed period that didn't have a surgical correction was 51. Table 3 shows that there were no children with complex CHD that didn't undergo surgical correction.

Table 4. The children with CHD who are followed in pediatric cardiology counseling center

Age	ECG with or without changes	US verified-not verified CHD	Surgically treated	Conservative
0-1 month	YES 1(0,6%) NO 2(1,2%)	3(1,81%) /	/ /	3(4,11%)
2-12 months	YES 7(4,22%) NO 30(18,07%)	43(25,9%) /	6(6,45%) /	37(50,68%) /
2-3 years	YES 15(9,04%) NO 59(35,45%)	74(44,58%) /	49(52,69%) /	25(34,25%)
4-6 years	YES 3(1,81%) NO 36(21,68%)	33(19,88%) /	27(29,03%) /	6(8,22%)
7-12 years	YES 2(1,2%) NO 11(6,63%)	13(7,83%) /	11(11,83%) /	2(2,74%) /

Source: Authors research

The total number of children with the CHD who were monitored was 166, of which 93 children had surgical correction, and 73 children were on conservative therapy. Out of the total number of observed children, 28 of them had changes on the ECG, and 138 children had no changes on the ECG.

Table 5. The children without CHD who are involved in sport, and who underwent ultrasound examination

Age	EKG or without changes		US verified-not verified CHD	
6-12 years	YES M 5 (10%)	F 3 (6%)	M 3 (6%)	F 1 (2%)
			17 (34%)	8 (16%)
	NO 15 (30%)	6 (12%)		
13-18 years	YES M 9 (18%)	F 4 (8%)	M /	F /
			15 (30%)	6 (12%)
	NO 6 (12%)	2 (4%)		
TOTAL	**M 35 (70%)**	**F 15(30%)**	**M 35 (70%)**	**F 15(30%)**

Source: Authors research

The observed number of children who were examined at the Pediatric Cardiac Counseling Center was 50, of which 14 boys and 7 girls had changes on the ECG, and the other 21 boys and 8 girls had no changes on the ECG. Out of the total number of observed children engaged in sports, 3 boys and 1 girl had a proven CHD.

4. DISCUSSION

Preventive examinations of children who are involved in sports are part of primary prevention measures that enable the detection of CHD in children athletes who do not have symptoms at an early stage. Therefore, the two most influential world cardiology organizations: the American Heart Association (AHA) and the European Society of Cardiology (ESC), as well as the American Academy of Pediatrics (AAP) in collaboration with the American Academy of Family Physicians (AFA) recommended the introduction of preventive examinations of athletes as a strategy for early detection of asymptomatic CHD. (9) Systematic preventive examinations that include an electrocardiogram (ECG) can significantly change the situation. A standard 12-channel ECG significantly increases the sensitivity of preventive examination in athletes, up to 66%, because it can detect various heart disorders and other structural abnormalities of the heart. (10)

A large number of children with CHD have reduced ability to exercise and generally low level of physical activity. Low level of physical activity in children with CHD is due to sometimes excessive restrictions imposed on them by parents, educators, and sometimes due to their misconception that the risk outweighs the benefits of physical activity. (11)

In developing countries, the burden of CHD is increasing day by day due to the increase in risk factors such as old age of mothers, infections during pregnancy, etc. (12)

According to Burki and Babar, in the study most cases of CHD - 74.7% were diagnosed in infancy, and 59.3% of cases first visited tertiary pediatric cardiology center during the 1st year of life. The diagnosis was made in 75.43% of cases under the age of one, in a study conducted in Khazar. (13)

From the results of our research and the research of other authors, we see the frequency of simple and complex CHD. According to the results of research by other authors, CHD are most often present in early infancy at 1 year of age, up to 3 years of age, which is consistent with the results of our study, where more children with congenital heart anomalies are at an early age.

CHD that most often require transplantation at a later age after surgery are lesions with a functional single ventricle (HLHS, pulmonary and tricuspid atresia) and L and D transposition of great arteries (14, 15).

Durakovic and co-workers conducted several retrospective studies that observed the incidence of sudden cardiac death during or immediately after physical activity in young athletes and recreational athletes and analyzed the circumstances in which the deaths occurred. Over a 27-year period (1984 to 2010), 69 fatal events were identified during physical activity, mostly in recreational athletes, and the incidence of sudden cardiac death in young athletes was less than 0.2 per 100,000 athletes per year (16).

5. CONCLUSION

Distribution of simple and complex CHD in children in the observed period ranges from 0.01 to 0.50% of the total number of live births. The percentage of children who were surgically treated in the observed period ranged from 0.01 to 0.34% in relation to the total number of live births. Pediatric check-ups help monitor children with CHD and prevent possible new complications, even after surgical treatment. The results of the research indicate that ultrasonography is an important method in the detection and

treatment of CHD.

REFERENCES

Ristić, S. R. (2012). Uloga ultrazvuka u dijagnostici ranog reumatoidnog artritisa. Biomedicinska istraživanja, 3(2), 77-82.
Donald, I., & Brown, T. G. (1961). Demonstration of tissue interfaces within the body by ultrasonic echo sounding. British Journal of Radiology, 34, 539-546.
Kos, M., & Kurjak, A. (2000). Ultrazvučni biljezi kromosomopatija. In A. Kurjak, A. Stavljenić-Rukavina, & K. Pavelić (Eds.), Prenatalna dijagnostika i terapija. Varaždinske Toplice: Nakladnička kuća Tonimir.
Wagner, J. (2010). Suvremene metode prenatalne dijagnostike. Osijek: Medicinsko Vjesnik.
Stipoljev, F. (2004). Prenatalni probir plodova rizičnih za pojavu kromosomskih i genskih poremećaja. Pedijatrijski Croat, 48, 192-196.
Rojnić, P. N., & Malčić, I. (2003). Epidemiologija prirođenih bolesti srca u Hrvatskoj – multicentrična nacionalna studija, 1995.-2000. Zagreb: Liječnički vjesnik.
Van Nisselrooij, E. L., Teunissen, A. K., Clur, S. A., Rozendaal, L., Pajkrt, E., Linskens, I. H., ... Haak, M. C. (2020). Why are congenital heart defects being missed? Ultrasound in Obstetrics & Gynecology, 55(6), 747-757.
Bar-Mor, G., Bar-Tal, Y., Krulik, T., & Zeevi, B. (2000). Self-efficacy and physical activity in adolescents with trivial, mild, or moderate congenital cardiac malformations. Cardiology in the Young, 10(6), 561-566.
Lee, K. C. (2017). Prenatal Counseling of Fetal Congenital Heart Disease. In G. Singh (Ed.), Pediatric Congenital Heart Disease. University School of Medicine, 19, 5.
Holland, B. J., Myers, J. A., & Woods Jr, C. R. (2015). Prenatal diagnosis of critical congenital heart disease reduces the risk of death from cardiovascular compromise prior to planned neonatal cardiac surgery: a meta-analysis. Ultrasound Obstetrics & Gynecology, 45, 631–638.
Centers for Disease Control and Prevention. (2020, November 17). What are Congenital Heart Defects? National Center on Birth Defects and Developmental Disabilities, Centers for Disease Control and Prevention. Retrieved August 18, 2021, from https://www.cdc.gov/ncbddd/heartdefects/facts.html
Maron, B. J., Thompson, P. D., Ackerman, M. J., et al. (2007). Recommendations and considerations related to preparticipation screening for cardiovascular abnormalities in competitive athletes: 2007 update: a scientific statement from the American Heart Association Council on Nutrition, Physical Activity, and Metabolism: endorsed by the American College of Cardiology Foundation. Circulation, 115(12), 1643–1655.
Lolgen, H., Borjesson, M., Cummiskey, J., Bachl, N., & Debruyne, A. (2015). The Pre-participation Examination in Sports: EFSMA Statement on ECG for Pre-Participation Examination. Deutsche Zeitschrift für Sportmedizin, 66, 151-156.
Khalil, A., Aggarwal, R., Thirupuram, S., & Arora, R. (1994). Incidence of congenital heart disease among hospital live births in India. Indian Pediatrics, 31(5), 519–527.
Kaluđer, A. (2016). Prirođene srčane greške i genetski sindromi u kojima se javljaju. (Diplomski rad). Osijek: Medicinski fakultet.
Duraković, Z., Misigoj-Duraković, M., Skavić, J., & Tomljenović, A. (2008). Myopericarditis and sudden cardiac death due to physical exercise in male athletes. Collegium Antropologicum, 32, 399-401.