Vol. 4 No. 4 (2025)

Pakistan Journal of Medical & Cardiological Review

https://pakjmcr.com/index.php/1/about

Online ISSN 3007-2387

Print ISSN 3007-2379

Pattern of Various Types of Isolated Patent Ductus Arteriosus on The Basis of Echocardiographic Examination among Various Age Groups in Tertiary Care Hospital Peshawar

Saeed Ahmad
Lecturer Cardiology Technology Institute of paramedical Sciences Khyber Medical University Peshawar
Email: saeed.ipms@kmu.edu.pk
Mehtab Ali
Students of BS-Cardiology Technology, Institute of Paramedical Sciences Khyber Medical University Peshawar
Email: m3htab.alii@gmail.com
Muhammad Awais
Students of BS-Cardiology Technology, Institute of Paramedical Sciences Khyber Medical University Peshawar
Email: awaiskarni4490@gmail.com
Dr Sadia Ilyas
Associate Professor Peads Cardiology Lady Reading Hospital Peshawar-MTI
Email: saadia76@gmail.com
Bashir Ullah*
Faculty of Cardiology and Cardiac Perfusion Technology Institute of paramedical Sciences Khyber Medical University Peshawar
Email: bashir.ipms@kmu.edu.pk

Author Details

Mr. Bashir Ullah*
Faculty of Cardiology and Cardiac Perfusion Technology Institute of paramedical Sciences Khyber Medical University Peshawar
Email: bashir.ipms@kmu.edu.pk

Keywords:

Received on 25 Aug 2025
Accepted on 20 Sep 2025
Published on 01 Oct 2025

Abstract

Background: By 72 hours after birth, nearly 100% of term infants should have complete anatomical closure of the ductus arteriosus When the ductus arteriosus fails to close within 72 hours after birth, it is referred to as a "Patent Ductus Arteriosus" (PDA). Isolated / uncomplicated PDA is defined as uncomplicated / isolated PDA with no duct dependent circulation, no signs of pulmonary vascular obstructive disease. According to krichenko angiographic classification types of PDA are classified using lateral aortography into five types. Type A “Conical ductus” (most common) Type B “Window ductus type” Type C “Tubular ductus type” Type D “Saccular ductus type” Type E “Elongated ductus type”. We determine the pattern of various type of PDA on echocardiographic examination. The echocardiography is the gold standard and reliable tool for diagnosing PDA. Objectives: To Determine Frequency of Various Type of Isolated Patent Ductus Arteriosus on The Basis of Echocardiographic Examination Among Various Age Groups in Tertiary

Care Hospital. Material and Methods: A descriptive cross-sectional was conducted at the Lady Reading Hospital, Peshawar (LRH). This study examined 101 children who had isolated PDA. The pediatricians at the same hospital handled the follow-up. The time duration of the study was from May 2023 to October 2023. Result: With a total size n= 101(100%) participants were observed in our study who met all our inclusion criteria. Out of total sample size male participant were n=51(50.5%) while female participant was n=50 (49.5%). The age of participant was distributed into three groups (1, 2, 3). Group 1 (less than 01 year) 42.6%. Group 2 (01 to 05 year) 45.5%. and Group 3 (05 to 10 years) 11.95%. The mean and standard deviation (SD) of upper limb saturation was 93.32+5.48 and lower limb saturation was 91.72+ 7.83. Different types of PDA were observed, Types A, B, C, D, and E are conical, window, tubular, complicated, and elongated, respectively. so, our aim was to determine the pattern of different types of PDA at LRH Peshawar. In our data collection the most common type of PDA was type A with a percentage of 61.4%. size of PDA was observed, moderate size of PDA was common among predefine age groups patient, percentage of moderate sized PDA was 55.4%

Introduction

Congenital heart disease (CHD) represents one of the most prevalent birth defects worldwide, affecting approximately 1.35 million infants annually, with an estimated incidence of 1 per 100 live births. Characterized by structural abnormalities in the heart or major cardiothoracic blood vessels, CHD encompasses over 25 clinical types, including tetralogy of Fallot (TOF), patent ductus arteriosus (PDA), transposition of the great arteries (TGA), aortic stenosis (AS), and pulmonary stenosis (PS). These defects arise from disruptions in the intricate embryonic development of the heart, potentially leading to hemodynamic and anatomical lesions that impair cardiac function. Historically, only a small fraction of patients with moderate to severe CHD survived to adulthood, but advances in neonatal care have improved outcomes. In regions like Pakistan, around 40,000 children are born with CHD each year, underscoring the need for early detection and intervention to mitigate long-term complications such as heart failure, pulmonary hypertension, and reduced quality of life (1,2).

The etiology of CHD is multifactorial, involving genetic, environmental, and chromosomal factors that interfere with normal heart development during embryogenesis. Genetic contributions include inherited mutations passed from parents, de novo somatic mutations arising spontaneously, and associations with syndromes like Down syndrome or Marfan syndrome. Non-genetic influences encompass maternal exposures during pregnancy, such as infections (e.g., rubella, cytomegalovirus, toxoplasmosis), alcohol consumption leading to fetal alcohol syndrome, certain prescription drugs, environmental teratogens (e.g., pesticides, radiation), and metabolic disturbances like poorly controlled diabetes. CHD can manifest as syndromic forms, linked to broader genetic syndromes with extracardiac features, or isolated/non-syndromic types affecting single genes critical for cardiac development. This spectrum highlights the importance of genetic counseling and comprehensive risk assessment, particularly in families with a history of CHD, maternal lupus, rubella exposure in the first trimester, or lithium therapy during pregnancy (3,4).

Among CHD variants, patent ductus arteriosus (PDA) is a focal concern, occurring when the fetal ductus arteriosus a temporary vessel connecting the pulmonary artery to the descending aorta fails to close postnatally. In fetal circulation, the ductus arteriosus shunts oxygenated blood away from the uninflated lungs, but at birth, physiological changes like rising oxygen tension, falling prostaglandin levels, and

fibromuscular remodeling typically induce closure within 72 hours, transforming it into the ligamentum arteriosum (5). Failure of this process, often exacerbated by preterm birth or low birth weight, results in persistent left-to-right shunting, leading to symptoms such as systolic murmurs, shortness of breath, fatigue, and risks of Eisenmenger syndrome, endarteritis, heart failure, and pulmonary edema. Prevalence is higher in preterm infants (up to 30% in those weighing 501–1500 g), compared to 57 per 100,000 in term newborns. Diagnosis relies on tools like ECG, chest X-ray, echocardiography, pulse oximetry, and cardiac catheterization, with medical therapies (e.g., indomethacin, ibuprofen) or surgical options for management. This study aims to determine the frequency of various types of isolated PDA based on echocardiographic examination across age groups in a tertiary care hospital, informing targeted screening and treatment strategies (6,7).

Congenital heart disease is defined as a significant, functionally relevant gross structural abnormality of the heart or intrathoracic great vessels, accounting for a substantial portion of perinatal and infant mortality in developing countries. In North America, CHD occurs in 8.1 per 1,000 live births, representing about 1% of newborns annually in the USA, with a Canadian study reporting prevalence's of 6.1% in adults and 13.1% in children. In Asia, the rate is 9.3 per 1,000 live births, influenced by factors like higher paternal age. Advances in neonatal care and interventions have enhanced survival, yet gaps persist in long-term outcomes for specific anomalies. Epidemiological studies, such as those by Dastgiri and Agha, emphasize multi-year survival documentation, revealing that mortality varies by anomaly type and comorbidities (e.g., respiratory, central nervous system, or genetic disorders). Leek et al. observed the highest mortality in complex cases, highlighting the need for integrated care to address both cardiac and extracardiac issues (8,9).

Investigating the frequency of isolated PDA via echocardiography across age groups enables refined risk stratification, particularly in high-prevalence settings like preterm or low-birth-weight populations. By identifying patterns in tertiary care, this research supports proactive screening protocols, reducing delays in diagnosis and mitigating complications like pulmonary hypertension or heart failure. In resource-limited regions such as Pakistan, where 40,000 CHD cases occur yearly, such data could optimize resource allocation for indomethacin or ibuprofen therapy, improving survival rates and decreasing the burden on healthcare systems (10,11).

Understanding PDA's isolated forms contributes to a continuum model of CHD, bridging syndromic and non-syndromic etiologies. This facilitates targeted genetic counseling for families with histories of CHD or risk factors (e.g., maternal infections, diabetes), potentially lowering incidence through preventive measures like rubella vaccination or alcohol avoidance. Long-term, it informs public health policies, promoting awareness of de novo mutations and environmental teratogens, ultimately reducing global CHD prevalence and enhancing multidisciplinary care in cardiology and medical genetics (12,13).

In conclusion, congenital heart disease, exemplified by patent ductus arteriosus, poses a significant global health challenge due to its multifactorial origins and potential for severe outcomes if undetected. This study's focus on echocardiographic frequency of isolated PDA across ages addresses critical gaps in prevalence data, particularly in diverse populations. By integrating insights from anatomy, physiology, and epidemiology, the research not only advances diagnostic and therapeutic strategies but also underscores the value of early intervention in improving patient prognosis and quality of life. Ultimately, these findings could guide policy and education to curb CHD incidence, fostering healthier generations worldwide (14,15).

MATERIALS AND METHODS

Data collection procedure:

A descriptive cross-sectional was conducted at the Lady Reading Hospital, Peshawar (LRH). This study examined 101 children who had isolated PDA. The paediatricians at the same hospital handled the follow-up. The time duration of the study was from May 2023 to October 2023. The child was positioned in a recumbent position for the transthoracic 2D echocardiography. Informed consent was signed from the participants parents as intention to explained to them in their native language as to obey the ethical principle. After the approval of ethical committee of the institute and hospital the data was collected through questionnaire containing question related to medical record. we checked investigation like echocardiography and some proposed questions were asked from the participants and their guardian. The personal data of the participant was kept confidential. The investigation was done through echocardiography

Information Sources:

MEDLINE, PUBMED, GOOGLE SCHOLAR, and SCI HUB were searched prior to final data analysis. We looked for more related studies by speaking with subject matter experts directly, looking through the reference lists of relevant papers, and reading abstracts.

Sample size:

The total sample size for the study was 101(n=101) (15).

Inclusion Criteria:

Patient diagnosed and documented by expert cardiologist on the basis of echocardiography having isolated PDA.
Patient belonging to the age groups of from birth up to 10 years (16).

Exclusion Criteria:

ASD, VSD, TGA, PS.
Coarctation of aorta, truncus arteriosus (17)
Uncooperative Patients
Patients with incomplete records

Statistical Analysis:

All statistical data related to our research study was analyzed by using IBM SPSS "Statistical Package for Social Sciences" version 22. Mean and SD was computed for continuous data such as age etc. for quantitative variable we used descriptive statistics (18).

RESULTS:

With a total size n= 101(100%) participants were observed in our study who met all our inclusion criteria. Out of total sample size male participant were n=51(50.5%) while female participant was n=50 (49.5%). The age of participant was distributed into three groups (1, 2, 3). Group 1 (less than 01 year), Group 2 (01 to 05 year) and Group 3 (05 to 10 years). According to our inclusion criteria of various age groups the patients in group 2 (01 to 05 years) are in the highest percentage (45.5%), and the least number of patients among the aforementioned age are group 3 (05 to 10 years) with a percentage of 11.95% and their detail presentation are shown in table 1.

Table 1 Gender and Age frequency table:

Variables	Category	Frequency	Percentage (%)
Gender	Male	51	50.5
	Female	50	49.5
Age of the participants	Group 1	21	42
	Group 2	56	45.5
	Group 3	24	11.9

To get the saturation we placed the adhesive strip around baby thumbs, wrist, hand and foot. And connected to a monitor (pulse oximeter) by a long wire The mean of upper limb saturation was greater than lower limb saturation. The mean and standard deviation (SD) of upper limb saturation was 93.32+5.48 and lower limb saturation was 91.72+ 7.83. Which is mentioned in the table 2

Table 2 Mean and SD of Weight and Saturation (Upper and lower limb)

Variables		**Mean + SD**
Saturation	Upper limb	93.32+5.48
	Lower limb	91.72+7.83

Suprasternal window and Aorto-Pulmonary window are best to determine the size of PDA. The diameter of small sized PDA was 1 to 3mm, moderate sized PDA 3 to 6mm and large size PDA greater than 6mm. Size may vary with according to gestational weight and age of the patient. out of total 101 patients, the percentage of small size PDA was 20.8%, shows the least number among other age groups, percentage of moderate sized PDA was 55.4%, which was most common in predefine age groups patients. large sized PDA was 23.8%. The detail presentation is mentioned in Figure 1.

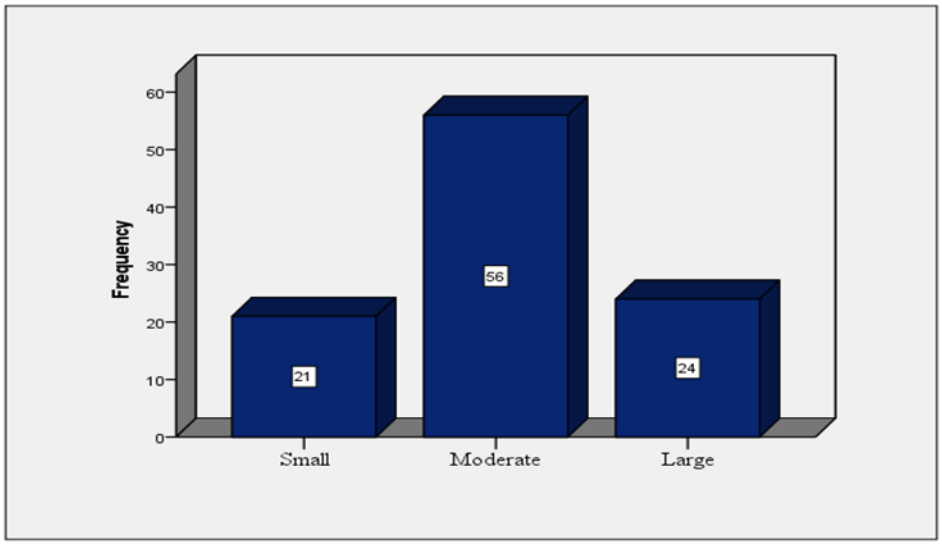

Figure 1: Size Of PDA

Types A, B, C, D, and E are conical, window, tubular, complicated, and elongated, respectively. so, our aim was to determine the pattern of different types of isolated PDA at LRH Peshawar. In our data collection the most common type of PDA was type A with a percentage of 61.4%, while type C (Tubular) was the 2nd most common type of PDA with a percentage of 17.8%. and type D (complicated) was not common among the predefine age groups with a percentage of 5.9%. The detail presentation is seen in figure 2.

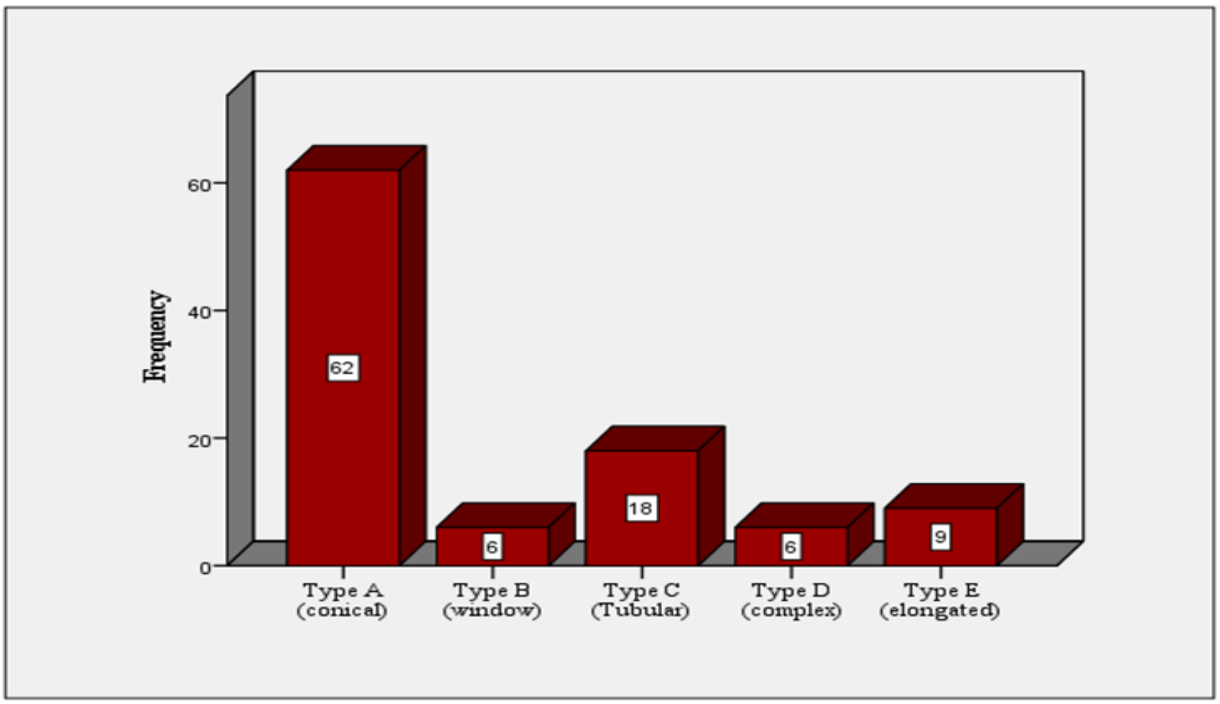

Figure 2: Types Of PDA

Two-dimensional echocardiography was used to measure the LV and LA dimensions and systolic performance. By using various assessment greater number of participants were having LA and LV dilatation with a percentage of 84.2%, and 15.2% percent do not have dilatation. The detail summary is shown in figure 11 below.

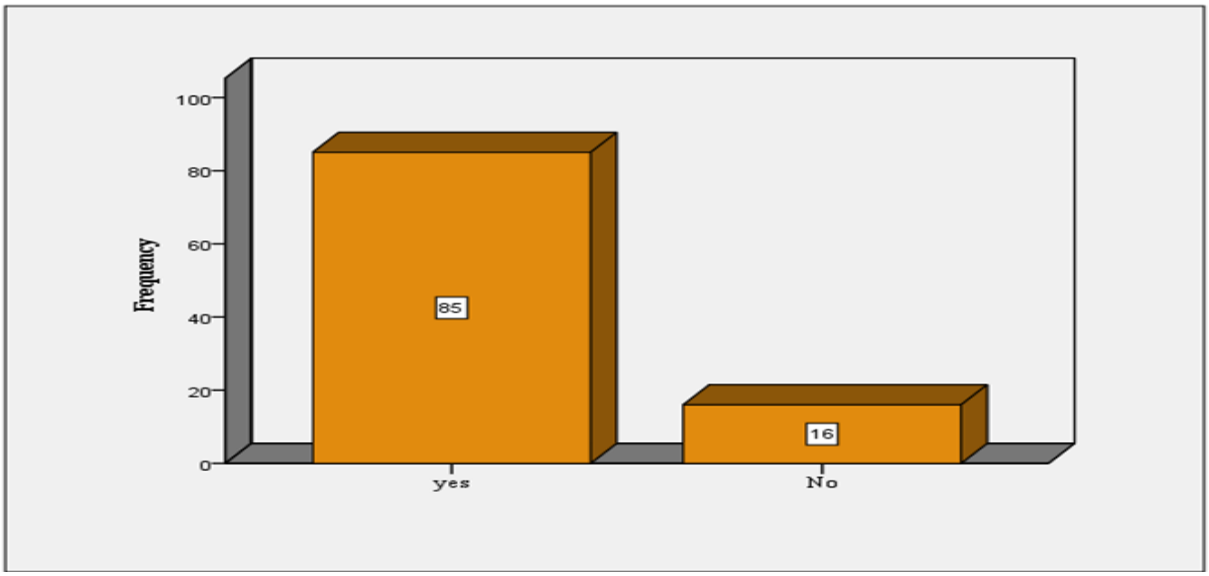

Figure 3: LA and LV dilatation

There is no more effective method than echocardiography to evaluate ductal shunting. Aortic and pulmonary artery flow ratios are used to calculate the shunt. Review of the spectral Doppler profiles across the ductus were available to verify the continuous left to right, right to left and bidirectional shunting. With isolated PDA the frequent significant hemodynamic changes are left to right shunting with percentage of 93.1%, right to left shunting 1.0% and the percentage of bidirectional shunting is 5.9%. The detail presentation of shunting across the ductus is mentioned in figure 3.

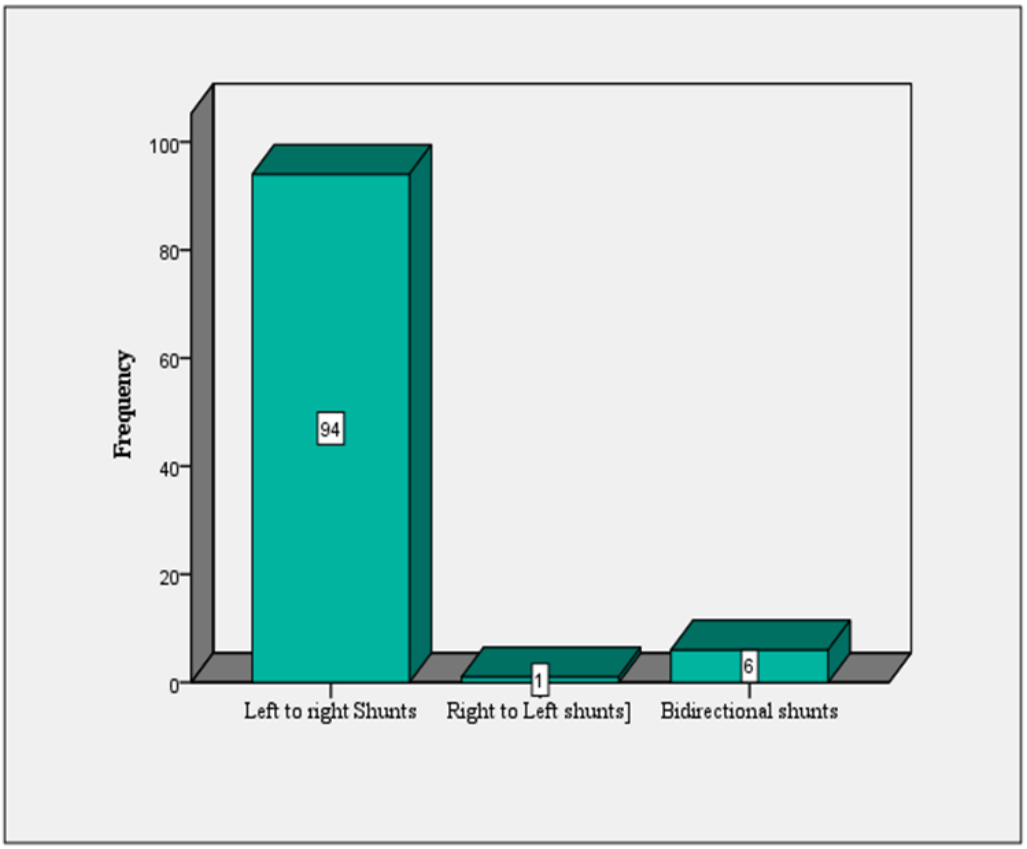

Figure 3: Shunting of PDA

DISCUSSIONS:

There were significant variations in the PDA's configuration. Due to restriction of the ductal smooth muscle at the pulmonary artery insertion, most tended to have a funnel or conical form, this indicates that the open channel tapers down as it gets closer to the aortic end and widens at the pulmonary artery insertion end, because of smooth muscle constriction at pulmonary end. Another variable in the PDA is its length. While some PDAs are short, others may be very long. PDAs can vary in size, with larger ones usually resulting in more severe symptoms and problems. while there were also narrowing's at the middle or aortic ends. The ductus takes on a conical or funnel-like shape when it shows signs of restriction (20,21).

In case the ductus is short or No length (group B), the topology of the structure can only be assigned by the degree of constriction The most common type of PDA is Type A PDAs, which comprised more than half of the population under evaluation. In our observation with a sample size of 101 we had 62 patient (61.4%) with type A PDA. This finding is in line with research by Krichenko et al (22, 23).

The second most common morphology of PDA, according to our data, is type C (tubular with large aortic and pulmonary orifices) (17.8%). and this observation is consistent with a study conducted in polish population (52). while according to krichenko angiographic classification type B PDA (short length, wide pulmonary and aortic orifice) are the most frequent. One of the studies was conducted on pearlitic patient to occlude different types of PDAs (24, 25).

They classify the morphology of PDA by krichenko angiographic classification. In their study 37.1% patients had Type A PDA, 15.3% patients had Type C PDA, 9.6% patients had Type D PDA, and 37.1% patients had Type E PDA. so, the conclusion on the basis of these studies was that Type A PDA is more common and frequent as related to other types of PDA's (19, 26).

while the types of PDA that's occurred in infant may be vary according to age and gestational weight. similarly, research was conducted by Naveen Garg et al and Bevunahalli Kantharaj Madan et al 73.5 percent of patients had a type A PDA; 17.1 percent of patients had a type B PDA; only 3.4% and 6.0% of patients, respectively, had a type C or type E PDA (27). In their study Type B PDA was the 2nd most common morphology while in our study Type C PDA is the 2nd most frequent type of PDA. So, all these variations are acceptable because it can may vary according to the population. So, our basic aim was to study the types of PDA on the basis of echocardiographic examination in various age groups (28).

In most of the patient LA and LV dilatation are present having isolated PDA. 84.2% patients had dilated LA and LV. LA and LV Dilatation with PDA is common and often present evidence from the reference article which have LV dilatation 27%, out of 141 patients. This was a cross-sectional study and deep information was mostly extracted from the peads cardiologist, research papers and electronic medical records (29,30)

CONCLUSIONS

The DA is an important component of the fetal circulatory system, and it is related to a large increase in newborn mortality and morbidity if it fails to close soon after delivery. A patent ductus arteriosus (PDA) is a persistence of the ductus arteriosus that has not closed during the first 72 hours of birth. Which is beyond the usual time frame. PDA can be treated with three different approaches: surgical ligation, pharmaceutical intervention, or fluid restriction while waiting for spontaneous closure. Echocardiography enables qualitative evaluation of PDA, including its type, morphology, length, and diameter. Both male and female participant were observed. We select those patients having isolated PDA and determined the pattern of various

types of PDA on the basis of echocardiographic examination. Type A (conical PDA) was the most common PDA and its study consistent with a previous mentioned article, type C (Tubular) PDA is the 2nd most common type of PDA. Saturation was obtained. after that various assessment was done to determine the size of PDA, and the most common was moderate size PDA. In the evaluated population with isolated PDA, the majority of patients had dilatation of LA and LV. Similarly left to right shunting was common in predefined population.

REFERENCES:

Kloesel B, DiNardo JA, Body SC. Cardiac embryology and molecular mechanisms of congenital heart disease. Anesth Analg. 2016;123(2):551-69.

Huang RT, Xue S, Wang J, Gu JY, Xu JH, Li YJ, et al. CASZ1 loss-of-function mutation associated with congenital heart disease. Gene. 2016;595(1):62-8.

Šamánek M. Children with congenital heart disease: probability of natural survival. Pediatr Cardiol. 1992;13(3):152-8.

Fahed AC, Gelb BD, Seidman JG, Seidman CE. Genetics of congenital heart disease: the glass half empty. Circ Res. 2013;112(4):707-20.

Williams K, Carson J, Lo C. Genetics of congenital heart disease. Biomolecules. 2019;9(12):769.

Yuan S, Zaidi S, Brueckner M. Congenital heart disease: emerging themes linking genetics and development. Curr Opin Genet Dev. 2013;23(3):352-9.

Stuckey D, Celermajer J. Congenital heart disease in neonates. Med J Aust. 1969;2(15):764-5.

Yarboro MT, Gopal SH, Su RL, Morgan TM, Reese J. Mouse models of patent ductus arteriosus (PDA) and their relevance for human PDA. Dev Dyn. 2022;251(3):424-43.

Levin M, McCurnin D, Seidner SR, Yoder B, Waleh N, Goldbarg S, et al. Postnatal constriction, ATP depletion, and cell death in the mature and immature ductus arteriosus. Am J Physiol Regul Integr Comp Physiol. 2006;290(2): R359-65.

Evans N. Preterm patent ductus arteriosus: a continuing conundrum for the neonatologist? Semin Fetal Neonatal Med. 2015;20(4):272-7.

Ovalı F. Molecular and mechanical mechanisms regulating ductus arteriosus closure in preterm infants. Front Pediatr. 2020; 8:1-19.

Celermajer DS, Sholler GF, Hughes CF, Baird DK. Persistent ductus arteriosus in adults. A review of surgical experience with 25 patients. Med J Aust. 1991;155(4):233–6.

Antonucci R, Bassareo P, Zaffanello M, Pusceddu M, Fanos V. Patent ductus arteriosus in the preterm infant: new insights into pathogenesis and clinical management. J Matern Fetal Neonatal Med. 2010;23 Suppl 3:34-7.

Warnes CA, Williams RG, Bashore TM, Child JS, Connolly HM, Dearani JA, et al. ACC/AHA 2008 Guidelines for the Management of Adults with Congenital Heart Disease. J Am Coll Cardiol. 2008;52(23): e143-263.

Clyman RI. Patent ductus arteriosus, its treatments, and the risks of pulmonary morbidity. Semin Perinatol. 2018;42(4):235-42.

Buchanan JW, Sci MM. Types and treatment. Cardiology. 2001;3(1):7-16. [Note: "Sci MM" may be a journal or author abbreviation; formatted as provided.]

Reller MD, Strickland MJ, Riehle-Colarusso T, Mahle WT, Correa A. Prevalence of congenital heart defects in metropolitan Atlanta, 1998-2005 J Pediatr. 2008;153(6):807-13.

Pierpont ME, Brueckner M, Chung WK, Garg V, Lacro RV, McGuire AL, et al. Genetic basis for congenital heart disease: revisited: a scientific statement from the American Heart Association. Circulation. 2018;138(21): e653-711.

van der Linde D, Konings EEM, Slager MA, Witsenburg M, Helbing WA, Takkenberg JJM, et al. Birth prevalence of congenital heart disease worldwide: a systematic review and meta-analysis. J Am Coll Cardiol. 2011;58(21):2241-7.
Sun RR, Liu M, Lu L, Zheng Y, Zhang P. Congenital heart disease: causes, diagnosis, symptoms, and treatments. Cell Biochem Biophys. 2015;72(3):857-60.
Mitchell SC, Korones SB, Berendes HW. Congenital heart disease in 56,109 births. Incidence and natural history. Circulation. 1971;43(3):323-32.
Tennant PWG, Pearce MS, Bythell M, Rankin J. 20-year survival of children born with congenital anomalies: a population-based study. Lancet. 2010;375(9715):649-56.
Stone DH. Long-term survival of children born with congenital anomalies. Lancet. 2010;375(9715):614-6.
Zulqarnain A, Younas M, Waqar T, Beg A, Asma T, Ahmad Raza Baig M. Comparison of effectiveness and cost of patent ductus arteriosus device occlusion versus surgical ligation of patent ductus arteriosus. Pak J Med Sci. 2016;32(4):974-7.
Hajj H, Dagle JM. Genetics of patent ductus arteriosus susceptibility and treatment. Semin Perinatol. 2012;36(2):98-104.
Osinsky V. Lithuanian University of Health Sciences Patent Ductus Arteriosus at Neonates: Diagnostics and Treatment Strategies. 2023:1-41.
Toda T, Tsuda N, Takagi T, Nishimori I, Leszczynski D, Kummerow F. Ultrastructure of developing human ductus arteriosus. J Anat. 1980;131(Pt 1):25-37.
Yokoyama U. Prostaglandin E-mediated molecular mechanisms driving remodeling of the ductus arteriosus. 2015:820-7.
Silver MM, Freedom RM, Silver MD, Olley PM. The morphology of the human newborn ductus arteriosus: a reappraisal of its structure and closure with special reference to prostaglandin E1 therapy. Hum Pathol. 1981;12(12):1123-36.
Rudolph AM. The changes in the circulation after birth. Their importance in congenital heart disease. Circulation. 1970;41(2):343-59.