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Assessment of incidence and risk factors of congenital heart diseases in children of north Bihar region

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Abstract

Congenital Heart Disease (CHD) comprises one of the major diseases in pediatric age group. Among the all congenital malformations, Congenital Heart Disease is leading cause of morbidity and mortality in children. Congenital heart disease is defined as structural malformation of heart or intra-thoracic great vessels present since birth that is actually or potentially of functional significance regardless of the age of detection. Hence based on above literature findings the present study was done for assessment of Incidences and risk factors of congenital heart diseases in Children of North Bihar region.

The present study was done in Department of Pediatrics, Darbhanga Medical College and Hospital, Laheriasarai, Darbhanga, Bihar, India. Out of the total children referred to our hospital 50 newly diagnosed cases with the Congenital Heart Diseases were enrolled in the present study. Study group was first assessed clinically according to a preformed proforma including sex and age of presentation & undergone antenatal history, routine investigations, chest x-ray, ECG. Final diagnosis was confirmed by Echocardiography, then analysed to know pattern of congenital heart disease.

The data generated from the present study concludes that Ventricular Septal defect as well as Tetralogy of Fallot is most common abnormality that needs detection of risk factors in pregnant mothers and early interventional treatments for diseases. Several antenatal factors were found to be associated with the incidence of congenital heart disease emphasizing the need to prioritize antenatal care and counselling to pregnant mothers along with good maternal nutrition and folic acid supplementation.

Keywords: congenital heart disease, risk factors, clinical parameters, treatment

Introduction

A congenital heart defect (CHD), also known as a congenital heart anomaly and congenital heart disease, is a defect in the structure of the heart or great vessels that is present at birth. Congenital heart disease diseases are an important cause of mortality and morbidity in children representing a major global health burden. There are different type of congenital heart defects which can be broadly classified as simple defects and complex defects. Signs and symptoms depend on the specific type of defect. Symptoms can vary from none to life-threatening. When present, symptoms may include rapid breathing, bluish skin (cyanosis), poor weight gain, refusal to feed and feeling tired. CHD does not cause chest pain. Most congenital heart defects are associated with other anomaly and common complication of CHD is heart failure [1].

The cause of a congenital heart defect is often unknown. Risk factors include certain infections during pregnancy such as rubella, use of certain medications or drugs such as alcohol or tobacco, parents being closely related, or poor nutritional status or obesity in the mother. Having a parent with a congenital heart defect is also a risk factor. A number of genetic conditions are associated with heart defects, including Down syndrome, Turner syndrome, and Marfan syndrome. Congenital heart defects are divided into two main groups: cyanotic heart defects and acyanotic heart defects, depending on whether the child has the potential to turn bluish in colour. The defects may involve the interior walls of the heart, the heart valves, or the large blood vessels that lead to and from the heart [1].

Congenital heart defects are partly preventable through rubella vaccination, the adding of iodine to salt, and the adding of folic acid to certain food products. Some defects do not need treatment. Others may be effectively treated with catheter based procedures or heart surgery. Occasionally a number of operations may be needed [6]. or a heart transplant may be required. With appropriate treatment, outcomes are generally good, even with complex problems [2].

Congenital heart defects are the most common birth defect. In 2015, they were present in 48.9 million people globally. They affect between 4 and 75 per 1,000 live births, depending upon how they are diagnosed. In about 6 to 19 per 1,000; they cause a moderate to severe degree of problems. Congenital heart defects are the leading cause of birth defect-related deaths: in 2015, they resulted in 303,300 deaths, down from 366,000 deaths in 1990 [3].

Signs and symptoms are related to type and severity of the heart defect. Symptoms frequently present early in life, but it is possible for some CHDs to go undetected throughout life [4]. Some children have no signs while others may exhibit shortness of breath, cyanosis, fainting [5]. heart murmur, under-development of limbs and muscles, poor feeding or growth, or respiratory infections. Congenital heart defects cause abnormal heart structure resulting in production of certain sounds called heart murmur. These can sometimes be detected by auscultation; however, not all heart murmurs are caused by congenital heart defects.

The genes regulating the complex developmental sequence have only been partly elucidated. Some genes are associated

with specific defects. A number of genes have been associated with cardiac manifestations. Mutations of a heart muscle protein, α-myosin heavy chain (MYH6) are associated with atrial septal defects. Several proteins that interact with MYH6 are also associated with cardiac defects. The transcription factor GATA4 forms a complex with the TBX5 which interacts with MYH6. Another factor, the homeobox (developmental) gene, NKX2-5 also interacts with MYH6. Mutations of all these proteins are associated with both atrial and ventricular septal defects; In addition, NKX2-5 is associated with defects in the electrical conduction of the heart and TBX5 is related to the Holt-Oram syndrome which includes electrical conduction defects and abnormalities of the upper limb. Another T-box gene, TBX1, is involved in velo-cardio-facial syndrome DiGeorge syndrome, the most common deletion which has extensive symptoms including defects of the cardiac outflow tract including tetralogy of Fallot [6].

The notch signaling pathway, a regulatory mechanism for cell growth and differentiation, plays broad roles in several aspects of cardiac development. Notch elements are involved in determination of the right and left sides of the body plan, so the directional folding of the heart tube can be impacted. Notch signaling is involved early in the formation of the endocardial cushions and continues to be active as they develop into the septa and valves. It is also involved in the development of the ventricular wall and the connection of the outflow tract to the great vessels. Mutations in the gene for one of the notch ligands, Jagged1 (JAG1), are identified in the majority of examined cases of arteriohepatic dysplasia (Alagille syndrome), characterized by defects of the great vessels (pulmonary artery stenosis), heart (tetralogy of Fallot in 13% of cases), liver, eyes, face, and bones. Though less than 1% of all cases, where no defects are found in the Jagged1 gene, defects are found in Notch2 gene. In 10% of cases, no mutation is found in either gene. For another member of the gene family, mutations in the Notch1 gene are associated with bicuspid aortic valve, a valve with two leaflets instead of three. Notch1 is also associated with calcification of the aortic valve, the third most common cause of heart disease in adults [7-8].

Mutations of a cell regulatory mechanism, the Ras/MAPK pathway are responsible for a variety of syndromes, including Noonan syndrome, LEOPARD syndrome, Costello syndrome and cardiofaciocutaneous syndrome in which there is cardiac involvement. While the conditions listed are known genetic causes, there are likely many other genes which are more subtle. It is known that the risk for congenital heart defects is higher when there is a close relative with one [9].

Known environmental factors include certain infections during pregnancy such as rubella, drugs (alcohol, hydantoin, lithium and thalidomide) and maternal illness (diabetes mellitus, phenylketonuria, and systemic lupus erythematosus). Alcohol exposure in the father also appears to increase the risk of congenital heart defects [10].

Being overweight or obese increases the risk of congenital heart disease. Additionally, as maternal obesity increases, the risk of heart defects also increases. A distinct physiological mechanism has not been identified to explain the link between maternal obesity and CHD, but both pre-pregnancy folate deficiency and diabetes have been implicated in some studies [11].

There is a complex sequence of events that result in a well formed heart at birth and disruption of any portion may result in a defect. The orderly timing of cell growth, cell migration, and programmed cell death ("apoptosis") has been studied extensively and the genes that control the process are being elucidated. Around day 15 of development, the cells that will become the heart exist in two horseshoe shaped bands of the middle tissue layer (mesoderm) [20]. and some cells migrate from a portion of the outer layer (ectoderm), the neural crest, which is the source of a variety of cells found throughout the body. On day 19 of development, a pair of vascular elements, the "endocardial tubes", form. The tubes fuse when cells between then undergo programmed death and cells from the first heart field migrate to the tube, and form a ring of heart cells (myocytes) around it by day 21. On day 22, the heart begins to beat and by day 24, blood is circulating [12].

At day 22, the circulatory system is bilaterally symmetrical with paired vessels on each side and the heart consisting of a simple tube located in the midline of the body layout. The portions that will become the atria and will be located closest to the head are the most distant from the head. From days 23 through 28, the heart tube folds and twists, with the future ventricles moving left of center (the ultimate location of the heart) and the atria moving towards the head [12].

On day 28, areas of tissue in the heart tube begin to expand inwards; after about two weeks, these expansions, the membranous "septum primum" and the muscular "endocardial cushions", fuse to form the four chambers of the heart. A failure to fuse properly will result in a defect that may allow blood to leak between chambers. After this happens, cells which have migrated from the neural crest begin to divide the bulbus cordis, the main outflow tract is divided in two by the growth a spiraling septum, becoming the great vessels—the ascending segment of the aorta and the pulmonary trunk. If the separation is incomplete, the result is a "persistent truncus arteriosis". The vessels may be reversed ("transposition of the great vessels"). The two halves of the split tract must migrate into the correct positions over the appropriate ventricles. A failure may result in some blood flowing into the wrong vessel (e.g. overriding aorta). The four-chambered heart and the great vessels have features required for fetal growth. The lungs are unexpanded and cannot accommodate the full circulatory volume. Two structures exist to shunt blood flow away from the lungs. Cells in part of the septum primum die creating a hole while muscle cells, the "septum secundum", grow along the right atrial side the septum primum, except for one region, leaving a gap through which blood can pass from the right artium to the left atrium, the foramen ovale. A small vessel, the ductus arteriosus allows blood from the pulmonary artery to pass to the aorta [12].

The ductus arteriosus stays open because of circulating factors including prostaglandins. The foramen ovale stays open because of the flow of blood from the right atrium to the left atrium. As the lungs expand, blood flows easily through the lungs and the membranous portion of the foramen ovale (the septum primum) flops over the muscular portion (the septum secundum). If the closure is incomplete, the result is a patent foramen ovale. The two flaps may fuse, but many adults have a foramen ovale that stays closed only because of the pressure difference between the atria [12].

Many congenital heart defects can be diagnosed prenatally by fetal echocardiography. This is a test which can be done during the second trimester of pregnancy, when the woman

is about 18–24 weeks pregnant. It can be an abdominal ultrasound or transvaginal ultrasound. If a baby is born with cyanotic heart disease, the diagnosis is usually made shortly after birth due to the blue colour of their skin (called cyanosis). If a baby is born with a septal defect or an obstruction defect, often their symptoms are only noticeable after several months or sometimes even after many years. [13].

CHD may require surgery and medications. Medications include diuretics, which aid the body in eliminating water, salts, and digoxin for strengthening the contraction of the heart. This slows the heartbeat and removes some fluid from tissues. Some defects require surgical procedures to restore circulation back to normal and in some cases, multiple surgeries are needed.

Interventional cardiology now offers patients minimally invasive alternatives to surgery for some patients. The Melody Transcatheter Pulmonary Valve (TPV), approved in Europe in 2006 and in the U.S. in 2010 under a Humanitarian Device Exemption (HDE), is designed to treat congenital heart disease patients with a dysfunctional conduit in their right ventricular outflow tract (RVOT). The RVOT is the connection between the heart and lungs; once blood reaches the lungs, it is enriched with oxygen before being pumped to the rest of the body. Transcatheter pulmonary valve technology provides a less-invasive means to extend the life of a failed RVOT conduit and is designed to allow physicians to deliver a replacement pulmonary valve via a catheter through the patient's blood vessels. Many people require lifelong specialized cardiac care, first with a pediatric cardiologist and later with an adult congenital cardiologist. There are more than 1.8 million adults living with congenital heart defects [14].

Congenital Heart Disease (CHD) comprises one of the major diseases in pediatric age group. Among the all congenital malformations, Congenital Heart Disease is leading cause of morbidity and mortality in children. Congenital heart disease is the structural abnormalities of heart or intra-thoracic great vessels present since birth that is actually or potentially of functional significance regardless of the age of detection.

Methodology

The present study was done in Department of Pediatrics, Darbhanga Medical College and Hospital, Laheriasarai, Darbhanga, Bihar, India.

Inclusion Criteria: Children of age group 1 month to 12 yrs, first time diagnosed for CHD.

Exclusion Criteria: Old cases already evaluated by Echocardiography and came for follow up; Children with acquired heart disease; Unstable patients who died before the confirmation of diagnosis; Congenital arrhythmia (Wolff-Parkinson-white syndrome, Long QT syndrome); Documented hydrops foetalis; Functionless abnormalities of great vein (persistent left superior venacava).

Out of the total children referred to our hospital 50 newly diagnosed cases with the Congenital Heart Diseases were enrolled in the present study. Study group was first assessed clinically according to a preformed proforma including sex and age of presentation & undergone antenatal history, routine investigations, chest x-ray, ECG. Final diagnosis was confirmed by Echocardiography, then analysed to know pattern of congenital heart disease.

All the patients were informed consents. The aim and the objective of the present study were conveyed to them. Approval of the institutional ethical committee was taken prior to conduct of this study.

Results and Discussion

Congenital Heart Disease (CHD) comprises one of the major diseases in paediatric age group and is one of the leading causes of death in children with congenital malformations. Congenital heart disease is the structural or functional heart disease present at the time of birth, even if it is detected later on [15]. The incidence of CHD in the normal population is approximately 0.5- 0.8% of live born children, with a higher percentage in those aborted spontaneously or still born [16]. In our country majority of child births still takes place at home & routine neonatal screening is not common, so it is difficult to calculate the true birth prevalence of CHD. To detect as many children with CHD as possible, including those with mild lesions, very intensive studies are required which may not be available at all hospitals.

Congenital heart disease (CHD) is the most frequently occurring congenital disorder, responsible for 28% of all congenital birth defects [17]. The birth prevalence of CHD is reported to be 8-12/1000 live births. [18-19] Considering a rate of 9/1000, about 1.35 million babies are born with CHD each year globally [20].

With rapid advances in diagnosis and treatment of CHD, vast majority of children born with CHD in high-income countries reach adulthood. However, this is not the case for children born in low- and middle-income countries (LMIC) as such advanced care is not available for all children. Considering a birth prevalence as 9/1000, the estimated number of children born with CHD every year in India approximates 240,000, posing a tremendous challenge for the families, society and health care system. This article discusses the current state of cardiac care available to children with CHD and how it has changed over last decade [21].

The birth prevalence of severe CHD has been consistently reported as 1.5 - 1.7/1000 live births [19, 22-23]. Use of echocardiography is associated with higher birth prevalence as many milder cases are also detected. [25-30] Similarly, hospital-based data is unlikely to be representative of community prevalence in LMIC where a substantial proportion of births occur at home. Critical CHD, especially those dependent on patency of ductus arteriosus, may go undiagnosed in these settings.

Most studies reported from India are on prevalence at a given point of time, and not on prevalence at birth. Many reported studies are based on data from pediatric patients reporting to hospitals leading to a possible sampling bias [9-14]. The profile of patients with CHD that present to healthcare facilities in LMIC is largely determined by the natural history of individual conditions. A high attrition of patients with serious CHD results in low frequency of these lesions encountered in hospital settings, and may contribute to the prevailing perceptions on their rarity.

Table 1: Basic Details

Characteristics	No. of Cases
Gender	
Male	28
Female	22
Delivery Type	

Normal Caesarean	23 27
Pregnancy Type Normal Assisted	 41 9
Family History No Yes	 42 8
Birth weight	2.6 – 3.7 kg
Gestational Age	35 – 39 weeks
Maternal Age	24 – 32 years

Table 2: Clinical Characteristics

Characteristics	No. of Cases
Type of Anomaly: Ventricular Septal Defect Tetralogy of Fallot Coarctation of Aorta Valvular Defect TGV/TGA Multiple Anomalies Patent Ductus Arteriosus	 15 9 2 10 2 6 6
Arrhythmia No Yes	 43 7
Ejection Fraction	59.4 – 63.8
O2 Saturation	91.2 – 98.8

Sonali Tank, Sushma Malik, Surekha Joshi carried out a retrospective study over a period of 4yrs in a public hospital in Central Mumbai [31]. The study included all children from birth to 12yrs admitted to Pediatric ward with proved CHD. Maximum children presented in the 1st year of life.60% of them had acyanotic CHD. The commonest symptom was breathlessness followed by respiratory tract infection & failure to thrive.

Rahim F, Younis M, Amin Jan Gandapur, Azmat Talat in their study conducted at Khyber teaching Hospital Peshawar in 2003 [32] found that 68% of children with CHD presented at age <5yrs & only 2% at age above 10yrs. 2/3 rd of total children had acyanotic cardiac lesion. Ventricular Septal Defect (VSD) followed by Aortic Stenosis (AS), mild pulmonic Stenosis (PS), Patent Ductus Arteriosus (PDA) & Atrial Septal Defect (ASD) were the commonest acyanotic CHD. Tetrology of Fallot (TOF) followed by Transposition of Great Arteries (TGA) & Tricuspid Artesia were the commonest cyanotic heart lesions.

Kasturi L, Kulkarni AV, Amin A, Mahashankar VA conducted a study in BARC Hospital, Mumbai [33] to ascertain the pattern of CHD in 108 subjects. 70% of them were diagnosed before the age of one year. In this study 82% belonged to acyanotic group, VSD being the commonest lesion & 18% belonged to cyanotic group; TOF was the commonest cyanotic lesion.

Murali Krishna N, Vijayalakshmi IB, Chitra N, Yavagal ST, Rajshree [34] studied the pattern & prevalence of CHD under 12yrs of age by Echocardiographic evaluation in Sri Jayadeva Institute Of Cardiology, Bangalore. In this study there was a female preponderance. Around 50% of the cases presented by age 1yr & 75% by age 5yrs.The majority (81.2%) were acyanotic & the rest (18.8%) were cyanotic CHD .Small ASDs, VSDs & PDAs which could be clinically silent, were picked up. Prevalence of COA & AS were low compared to western literature, but unlike other Indian studies prevalence of TOF was not high.

Chadha SL, Singh N, Shukla DK [35] from Sitaram Bhartia Institute of Science & Research, ICMR New Delhi conducted an epidemiological study on congenital heart disease in 2001. It was a community based randomized study on children below 15 yrs in Delhi. The VSD (46%) was the commonest lesion followed by ASD (18%).Prevalence of PDA, TOF, AS & PS were 14%, 10%, 4% & 4% respectively.

Sands A, Craig B, Mulholland C, Patterson C, Dornan James, and Casey Frank [36] conducted a randomized study at The Royal Maternity Hospital Belfast8 to assess the effectiveness and potential cost of an echocardiographic screening programme for CHD. Mothers were randomized before delivery. Study group underwent echocardiography whereas control group were assessed only on clinical grounds. Cases of CHD detected before hospital discharge were documented. The annual cost of screening was estimated and the time to accurate diagnosis in each group was assessed. Study concluded that adding echocardiography to clinical examination greatly enhances early detection of CHD. Although screening is expensive, once established it may reduce the cost of unnecessary outpatient referrals.

Rapid advances have taken place in the diagnosis and treatment of congenital heart defects over the last six decades. There are diagnostic tools available today by which an accurate diagnosis can be made even before birth. With currently available treatment modalities, over 75% of infants born with critical heart diseases can survive beyond the first year of life and many can lead near normal lives thereafter. However, this privilege of early diagnosis and timely management is restricted to children in developed countries only. Unfortunately, majority of children born in developing countries and afflicted with congenital heart disease do not get the necessary care, leading to high morbidity and mortality.

In India, where we have limited resources and poor access to health services, the family of the children with CHD have to face social stigma the economic burden of the treatment. In spite that the tools to diagnose the problem are available, people are not aware of these tools. It is not only a question of affordability but also a question of accessibility.

Conclusion

From the present study concludes that congenital heart diseases (CHDs) are an important cause of mortality and morbidity in children representing a major global health burden. Ventricular septal defect and Tetralogy of Fallot was most common abnormality that needs identification of risk factors and early interventional treatments. Although many of the CHDs were detected during infancy, a large number were missed and presented late because of lack of awareness and delayed referral. We found a significant association between incidence of CHDs and advanced parental age, bad obstetric history, febrile illness during pregnancy and a folic acid deficient diet. There is need to prioritize antenatal care and counselling to pregnant mothers that includes multivitamin and folic acid supplementation, screening for diabetes, and if possible, provision of detailed fetal cardiac evaluation in mother with bad obstetric history or those having febrile illness during first trimester. Injudicious use of drugs during antenatal period should be avoided.

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