Neonates with critical congenital heart defects: Impact of fetal diagnosis on immediate and short-term outcomes

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ABSTRACT

Background	:	Fetal echocardiography is being increasingly used for prenatal diagnosis of congenital cardiac malformations, but its impact on the neonatal outcomes in low- and middle-income countries is still unknown.
Aims	:	The objective of this study is to determine the impact of fetal echocardiography on immediate postnatal and short-term outcome in a tertiary pediatric cardiac center.
Study Design		This is a prospective study.
Materials and Methods	:	One hundred consecutive patients with critical congenital heart defects (CHD) requiring active medical or surgical interventions in the 1st month of life were included in the study. The detailed history, postnatal examination findings, and fetal echocardiogram report were recorded. They were divided into two groups as antenatally diagnosed and postnatally diagnosed. Pre- and post-procedural variables were compared between the two groups.
Results	:	Twenty-nine neonates were diagnosed antenatally while 71 were diagnosed postnatally. Totally, 10 babies (34.5%) among the antenatally diagnosed group were delivered in a tertiary health-care setup. The mean age at presentation was 0 day in the antenatally diagnosed group while 10 days (0–30 days) in the postnatally diagnosed group ($P = 0.01$). A total of 17 (58.6%) patients in the antenatal group had duct dependent CHD, and 15 (88.2%) of these patients were transported on prostaglandin E1. In comparison, 19/34 (55.9%) patients in the postnatal group were transported on prostaglandin. The pH on admission in the antenatal group was 7.32 ± 0.05 as compared to 7.28 ± 0.05 in the postnatal group ($P = 0.0004$). There were 4 (5.6%) deaths in the postnatal group during transfer. There was no significant difference in the postoperative variables in both groups.
Conclusions		Fetal echocardiography identifies patients with complex CHD resulting in better parental counseling, thus facilitating delivery at a tertiary care center and preoperative stabilization. This results in improved preoperative mortality and better stabilization.
Keywords	:	Critical congenital heart defects, fetal echocardiography, neonate

INTRODUCTION

Congenital heart defects (CHD) are believed to have an incidence of 8/1000 live births, which amounts to nearly 180,000 children that are born with CHD every year in India. A significant proportion of infant mortality (10%)

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is attributed to CHD due to numerous shortcomings in the care continuum.[1] Echocardiography is the gold standard in the diagnosis of CHD in most newborns and the only diagnostic modality of CHD in the fetus.[2] With the advancement of knowledge and techniques of fetal ultrasound, fetal echocardiography has become a routine investigation in developed nations. Diagnosis of CHD during fetal life not only identifies the cardiac lesion but may also lead to suspicion and detection of noncardiac abnormalities with a syndromic association. This information allows appropriate parental counseling about the disease condition, delivery planning, and immediate postnatal management to optimize the postnatal outcome.[3] However, whether and to what extent fetal cardiac screening modifies neonatal outcomes remains unknown in the low- and middle-income countries.[4] Reduced morbidity and mortality, following antenatal diagnosis, has been reported for various complex conditions in developed countries.[5] In India, fetal echocardiography is not widely available at present. Even in major cities, only 1%–2% of pregnancies currently avail fetal echocardiography.[6] In India, where <10% of neonates with critical cardiac lesions undergo timely detection and operative treatment, the impact of fetal echocardiography may be even more pronounced than those countries with robust neonatal screening and referral services. The objective of this study is to determine the impact of fetal echocardiography on immediate postnatal and short-term outcome in a tertiary pediatric cardiac center in Western India. We hypothesized that antenatal diagnosis of CHD will be associated with planned delivery at a tertiary center with cardiac services leading to and reduced mortality and morbidity.

MATERIALS AND METHODS

This is a prospective study conducted at a tertiary pediatric cardiac center in Western India. The study included 100 consecutive patients who presented to our center with critical CHD requiring intervention in the 1st month of life.

All neonates presenting to the emergency department or inborn in our hospital who were diagnosed to have congenital heart disease either antenatally or postnatally and required either transcatheter or surgical intervention within 1 month of life were included in the study. Neonates diagnosed with noncritical form of CHD, who did not require admission and were advised follow-up with surgery or transcatheter intervention at a later date were excluded from the study. Parental consents were taken before including the child in the study. The study was approved by the Institutional Ethics Committee.

All the neonates were evaluated clinically and with a chest radiogram (posteroanterior view), electrocardiogram,

and detailed transthoracic echocardiography. The retrospective patient review included a detailed antenatal history, review of antenatal ultrasound scan report, and fetal echocardiogram if it was done. In cases where fetal echocardiography was done, the fetal and neonatal transthoracic echo diagnoses were compared.

The clinical condition of the baby on admission was assessed, and a detailed transport history was obtained. Parameters such as oxygen requirement, use of prostaglandin E1 infusion, inotrope support, ventilatory requirement, and central line insertion were recorded at admission and again after initial stabilization of the child in emergency and pediatric cardiac intensive care unit. A venous blood gas including lactate levels was obtained immediately after admission. For inpatient admissions, a similar protocol was followed, and venous blood gas after delivery was taken in the neonatal intensive care unit.

The type of cardiac intervention required (surgical or transcatheter) was noted. For the surgical interventions, the total bypass time and aortic cross-clamp time were recorded. Postprocedure, the number of inotropes and duration of inotropic support, duration of ventilation, and hospital days were assessed. Any adverse neurological event such as convulsions or clinical neurological deficit in the pre- and post-operative period were recorded and taken as a surrogate of the immediate neurological outcome. Magnetic resonance imaging brain, electroencephalogram, or computed tomography of the brain were done where clinically indicated for the neurological deficit. The duration of stay in the intensive care unit and hospital was also recorded and used as an indicator of morbidity.

Statistical analysis

The patients were divided into two groups, namely, patients who were diagnosed with congenital heart disease antenatally and those who were diagnosed postnatally. Variables mentioned above were compared between the two groups using SPSS v21 (IBM, Philadelphia, PA, USA). The parametric variables were described as mean ± standard deviation, and nonparametric variables were described as median with range. Student's *t*-test was used for analysis of parametric data while Mann–Whitney test was used for analysis of nonparametric parameters. Chi-square test was used for comparison of categorical variables.

RESULTS

Totally, 100 consecutive neonates with critical CHD who needed either surgical or transcatheter interventions within the 1st month of life were included in the study, and they were divided into two groups.

Twenty-nine patients were diagnosed on fetal echocardiogram to have a CHD, among which only

8 (27%) patients were counseled thereafter by a specialist. The median gestational age for fetal echocardiogram was 24 weeks with a range of (18–29 weeks). Ten patients (34.5%) opted for delivery in a tertiary health-care setup where facilities for initial stabilization were available. All these ten children were stabilized and subjected to an echocardiogram within an hour after birth, and appropriate treatment was initiated. Nineteen patients were delivered elsewhere. In this group, 17 (58.6%) patients had duct-dependent CHD and 15 (88.2%) of these patients were transported on prostaglandin E1. Five neonates were admitted in an unstable state that required immediate intubation and inotropic support. Eight (27.6%) patients were on ventilator and 3 (10.3%) patients were in shock on presentation. There were no deaths in this group during transport.

Seventy-one patients were diagnosed postnatally, the median age at diagnosis was 10 days (0–30 days), and the median age at presentation to the hospital was 13.5 days (0–30 days). Thirty-four patients had duct-dependent CHD, but only 19 (55.9%) patients were transported on prostaglandin E1. Thirty-two (45%) patients were admitted in an unstable state, 25 patients (35.2%) were transferred on ventilator, and 10 (14.1%) patients presented in shock on admission.

There were 4 (5.63%) deaths in this group during transfer. Two of these neonates were diagnosed as transposition of great arteries with intact septum and two with obstructed type of total anomalous pulmonary venous connections. Two babies were brought dead to the emergency, and the death occurred during transfer of the child. Two others were transported in a critical state and had episodes of cardiac arrest on arrival and could not be resuscitated. Preoperative variables are summarized in Table 1.

After initial stabilization of the child and depending on the nature of the condition, the child was subjected to the treatment available. In the antenatally diagnosed group, 27 patients underwent surgical correction, and two patients underwent transcatheter intervention. Three (10.3%) patients had to undergo emergency procedures. In the postnatally diagnosed group, sixty patients underwent surgical correction, and 11 patients underwent transcatheter interventions. Twenty (28.2%) patients had to be taken up for emergency surgery or catheterization in this group. The postoperative parameters are summarized in Table 2. There was no difference among the postoperative mortality among the two groups.

Neurological outcome in the immediate postoperative period was determined by convulsions which were seen in 2 (6.89%) patients in the antenatally diagnosed group and 9 (13.43%) patients in the postnatally diagnosed group.

Table 1: Preoperative variables

Variable	Antenatal diagnosis	Postnatal diagnosis	*P*
Patients	29	71	
Age at diagnosis (median with range), days	Antenatal	10 (1-30)	
Age at presentation (median with range), days	0	13.5 (0-30)	0.01
Weight (kg)	2.96±0.69	3.10±0.54	0.41
Duct-dependent lesions (%)	17 (58.62)	34 (47.88)	0.32
Transferred on prostin (%)	15 (51.72)	19 (26.76)	0.12
pH on admission	7.32±0.05	7.28±0.05	0.002
Lactates on admission	2.70±1.07	3.17±1.72	0.17
Shock (%)	3 (10.34)	10 (14.92)	0.61
Transferred on ventilator (%)	8 (27.58)	25 (35.21)	0.46
Emergency procedures (%)	3 (10.34)	20 (29.85)	0.05
Deaths (%)	0	4 (5.63)	0.19

Table 2: The postoperative variables

Variable	Antenatal diagnosis	Postnatal diagnosis	*P*
Convulsions (%)	2 (6.89)	9 (13.43)	0.33
Inotropes needed (median with range), days	4 (0-12)	4 (0-20)	0.87
Ventilator (median with range), h	49 (0-49)	72 (0-744)	0.74
Intensive Care Unit stay (median with range), days	10 (1-10)	13 (3-27)	0.62
Hospital stay (median with range), days	15 (0-38)	15 (0-40)	0.87
Death (%)	1 (3.44)	2 (2.98)	1.0

DISCUSSION

Prenatal diagnosis has been shown to reduce morbidity in newborns with CHD; however, there is conflicting data as to the association with mortality.[7-9] In addition, the advantages of prenatal detection of cardiac anomalies in low-risk populations have not been clearly demonstrated.[10]

In our study, we found that neonates diagnosed antenatally presented to the hospital at an earlier age in a better condition as compared to the postnatally diagnosed groups. There was an average delay of 4 days from the day of diagnosis to admission in the cardiac care center, in our study, in the postnatally diagnosed group. We believe prenatal diagnosis helps in better understanding of CHD. It ensures that prenatal medical and interventional management if possible and delivery can be performed safely at a tertiary center. In a developing country like India, delay in admission could be due to delay in diagnosis, referral, financial, and social hindrances. The time needed for acceptance of the condition by the parents, arrangement of funds for transport, and the time needed for travel from a peripheral village to a major city further delay the presentation to a tertiary cardiac care center. In the absence of a strict newborn screening and limited echocardiogram availability, these children would present only after the closure of the ductus arteriosus. This delay results in hemodynamic instability leading to unfavorable outcomes.

Our data also suggest that patients who were counseled by a specialist after the detection of CHD opted for delivery in a tertiary care center with a well-equipped neonatal intensive care facility. All of these babies were subjected to an echocardiogram to confirm the diagnosis and prostaglandin E1 was started within an hour after delivery in duct-dependent conditions. An increasing experience with fetal cardiac scanning by obstetric ultrasonographers may increase the frequency of antenatal diagnosis of CHD.[11,12] Studies demonstrate that collaboration between the obstetrician and the pediatric cardiologist can significantly improve the rate of detected critical CHD.[3,13,14] Similar finding was noted in our study; hence, counseling of the couple by a specialist about the condition of the baby, need for early stabilization and intervention, and thus need to deliver the baby in a tertiary center should be mandatory.

There were four deaths, which were seen in the postnatally diagnosed group, which were mainly associated with the transport of the child from a peripheral unit to a tertiary center. This again highlights the challenges associated with transport of newborns in developing countries. It is important to stabilize the neonate and only then transport to a cardiac center with appropriate transport facility, but unfortunately, in India, we lack centers where a child with a cardiac abnormality can be stabilized. Transport of the expectant mother with fetal cardiac diagnosis seems to be the safest option in this situation. Changlani *et al.*, in their study, have pointed to the fact that it is difficult to get pediatric echocardiography done in a sick neonate in rural India, and consequently, there is a delay in starting life-saving medications such as prostaglandins.[15] In addition, we do not have a standardized neonatal screening program. Studies from the UK have shown a screening program helps in early neonatal diagnosis, stabilization, and referral to a tertiary care unit. In the absence of such a program, fetal echocardiography will be an important tool.

Our study highlights earlier hospital admissions and reduced mortality in the antenatally diagnosed group, thereby adding to the previously existing data of improved survival in the antenatally diagnosed group. Studies conducted in antenatally diagnosed babies with CHD have shown survival benefit with a better outcome in critical CHDs.[14,16-18] However, there are several other studies that have failed to demonstrate such benefit.[3,19-23]

In our study, there was no statistical difference in outcomes of these groups after initial stabilization after admission. This states the importance of timely referral of newborns as the adverse effects happened mainly during transport. There was significant difference in the incidence of postoperative convulsions between the two groups highlighting the higher incidence of hypoxic brain injury in children with critical CHD who have delay in

diagnosis and stabilization. Mahle *et al.*[24] suggested that prenatal diagnosis reduces early neurologic morbidity in patients with hypoplastic left heart syndrome but is not associated with reduced hospital mortality.

The limitations of our study are that only short-term outcomes until discharge are taken into account. It is a single-center study thereby the population characteristics could not be determined. Hence, our study mainly highlighted that antenatally diagnosed babies presented earlier and in a more stable state as compared to their postnatally diagnosed counterparts which is also in coordination to the American and European literature.[22,25,26]

CONCLUSIONS

The study has highlighted the importance of fetal echocardiography in improving preoperative mortality and morbidity. Detailed echocardiogram followed by thorough counseling can significantly improve immediate and long-term outcomes of CHD. In the absence of robust newborn screening, limited availability of echocardiogram in neonatal intensive care units and transport facility of a sick newborn, antenatal diagnosis can prove beneficial. Early intrauterine referral and planned deliveries with multidisciplinary approach could ensure timely care to the newborn, thereby reducing deaths during transport and preoperative stabilization in a low- and middle-income country like India.

Conflicts of interest

There are no conflicts of interest.

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