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Original Article

Paediatrics Section

Impact of Prenatal Diagnosis on the Management and Prognosis of Infants with Congenital Heart Disease- A Retrospective Study

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ABSTRACT

Introduction: Prenatal diagnosis is important in outcome of various congenital anomalies in recent times, especially in congenital heart diseases. The present study would help in recognising the importance of prenatal diagnosis and in understanding the management of newborns with congenital heart diseases.

Aim: To evaluate the impact of prenatal diagnosis on the management and prognosis of infants with congenital heart disease.

Materials and Methods: This retrospective study was conducted in Department of Paediatrics at Dr. Vasantrao Pawar Medical College, Nashik, Maharashtra, India, from January 2018 to January 2021. The study was performed on newborns who were diagnosed with Congenital Heart Diseases (CHD) during hospitalisation, in an inborn and outborn unit of Neonatal Intensive Care Unit (NICU). The data recorded for requirement of inotropes, ventilation, arterial blood gas analysis and outcome in the form of survival. The babies were classified into Prenatal ECHO (PNE) group and No Prenatal ECHO Available (NPEA) group, based on availability of prenatal Echocardiogram (ECHO) diagnostic report. CHDs were categorised into critical/major and minor. For the comparison of quantitative variables, Unpaired t-test/Mann-Whitney test was used. For the comparison of qualitative variable, Fisher's-exact test/Chi-square test was used, as necessary.

Results: There were 5000 admissions in the inborn and outborn neonatal unit during the study period, of which 159 cases had diagnosis of CHDs. The PNE group consisted of 61 neonates who had been diagnosed with CHD and the NPEA group consisted of 67 neonates who were not antenatally diagnosed to have CHD. Ionotropic support needed for PNE group (4.5%) was comparatively lesser than NPEA group (14.3%). Need for ventilation was reduced in PNE group (4.5%) as compared to NPEA group (14.3%). Mean for serum lactate and serum bicarbonate was 3.49±2.58 and 16.24±4.31 in PNE group, whereas, it was 5.08±2.79 and 15.12±4.13 in NPEA group on admission in NICU. In management of critical CHDs, 2/31 (6.5%) babies died in PNE group compared to 11/37 (29.7%) in NPEA group (p-value=0.09).

Conclusion: Antenatal diagnosis helps in meticulous management of neonates with congenital heart diseases in terms of fewer requirement of inotropes, need of ventilation and improved management. There was no significant difference in outcome in the form of survival.

Keywords: Antenatal echocardiography, Arterial blood gas analysis, Inotropes, Ventilation

INTRODUCTION

Congenital Heart Diseases (CHD), the most common congenital anomaly detected during pregnancy, havea significant impact on newborn after conception [1,2]. The prevalence of congenital cardiac abnormalities is roughly eight per 1000, in both developed and developing nations at the time of birth, with serious congenital heart defects accounting for half of newly diagnosed CHDs [3].

Antenatal scans, in the form of thorough foetal Echocardiogram (ECHO) in the late trimesters aid as secondary prevention techniques. Antenatal parental counselling plays an important role in diagnosis, management, treatment and parental education, following which the pregnant woman has a choice to continue or terminate the pregnancy with critical congenital heart diseases in foetus. Secondly, early diagnosis allows for modifications in obstetric and neonatal therapy, which improves the newborns outcome. In duct dependent congenital cardiac diseases, antenatal diagnosis lowers neonatal mortality and morbidity [4,5].

With prenatal identification of a lesion, one can counsel families about their child's cardiac disease and the anticipated course of lesion after the location and timing of delivery. It frequently avoids haemodynamic compromise, especially in CHD patients with duct dependent lesions. Prenatal diagnosis, on the other hand, does not appear to enhance hospital mortality in CHD patients, but several studies show that, early illness detection improves outcome because it allows for immediate medical care in a cardiac-friendly Neonatal Intensive Care Unit (NICU), reducing morbidity such as metabolic acidosis, hypoxaemia, and end-organ injury [6-8]. Several case series written in the western literature have contributed to a better understanding of improved survival for specific critical CHD lesions such as hypoplastic left heart syndrome [9], transposition of the great vessels [10], and critical juxta ductal coarctation of the aorta [11]. The study aimed to investigate impact of prenatal diagnosis on the management and prognosis of infants with congenital heart disease, in terms of requirement of inotropes, ventilation, arterial blood gas, and survival outcomes.

MATERIALS AND METHODS

This retrospective study was conducted in Department of Paediatrics at Dr. Vasantrao Pawar Medical College, Nashik, Maharashtra, India, from January 2018 to January 2021. Data analysis was done between May 2022 to June 2022. The Echocardiography

records of inborn and outborn neonates were assessed. Institutional Ethics Committee approval was obtained (IEC- 07/2018-19).

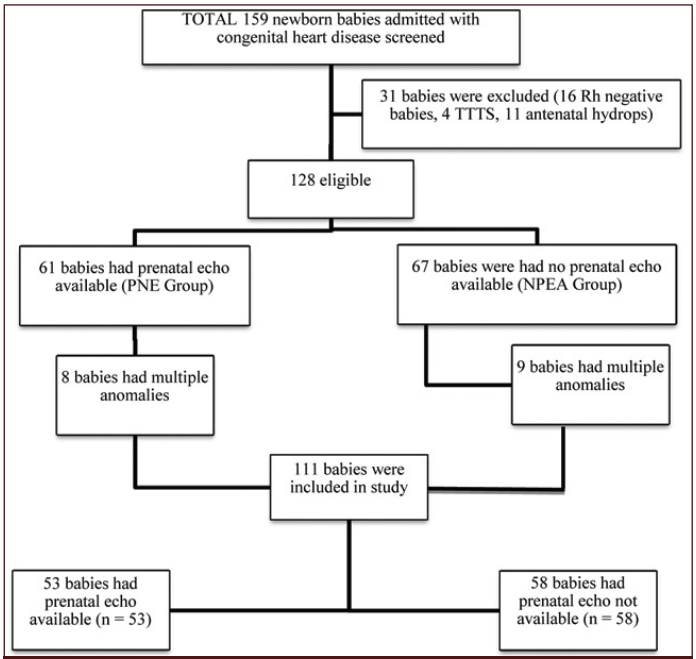
Inclusion criteria: Portable and advanced foetal and transthoracic echocardiography were used. All the hospitalised full term newborns (birth weight more than 2 kg) with CHD diagnoses, with or without prenatal diagnosis were included in the study.

Exclusion criteria: All preterms with haemodynamically significant Patent Ductus Arteriosus (PDA), Rh negative pregnancies with foetal anaemia diagnosed prenatally, hydrops, and twins with Twin to Twin Transfusion Syndrome (TTTS) were excluded from the study.

Study Procedure

Medical case sheets of the screened patients were reviewed retrospectively for gestational age at which diagnosis of CHDs was made; detailed first foetal echocardiography report (associated hydrops, oligohydramnios/polyhydramnios; other structural defects; subsequent follow-up Echocardiogram (Echo) reports noting their progression or subsidence); prenatal steroids; birth weight and gender, Appearance, Pulse, Grimace, Activity and Respiration (APGAR) scores; and presence of high-risk factors and associated co-morbidities {like Respiratory Distress Syndrome (RDS), Transient Tachypnoea Newborn (TTNB), Meconium Aspiration Syndrome (MAS), congenital pneumonia}; need for assisted ventilation on admission; blood pH, base excess, serum bicarbonate and serum lactate on admission. Furthermore, the following additional informations were also recorded- day of postnatal presentation, inotropes requirement on admission, and finally, their outcome (operative correction/discharged/death/discharged against medical advice/parental decision not to pursue cardiac surgery i.e, comfort care).

Newborns with conditions like Extremely Low Birth Weight (ELBW), Very Low Birth Weight (VLBW), severe sepsis, severe Meconium Aspiration Syndrome (MAS), syndromic associations and chromosomal anomalies, definite and advance Necrotising Enterocolitis (NEC), congenital diaphragmatic hernia were considered as high-risk newborns. There were 5000 admissions in the inborn and outborn neonatal unit during the study period, of which 159 cases had a diagnosis of CHDs [Table/Fig-1].



[Table/Fig-1]: Distribution of participants.

Babies were classified into:

- Prenatal ECHO (PNE) group
- No Prenatal ECHO Available (NPEA) group

Based on availability of prenatal Echo diagnostic report; CHDs were categorised into:

- Critical/major CHDs like duct dependent pulmonary circulations, duct dependent systemic circulations, heterotaxy syndrome and large intracardiac shunts were considered.
- Minor-minor CHDs like small patent foramen of ovale, small atrial septal defects, small ventricular septal defects and small patent ductus arteriosus were considered for operational use.

STATISTICAL ANALYSIS

The data were analysed by Statistical Package for the Social Sciences (SPSS) version 19.0 software. Quantitative variables were expressed as the mean with a confidence interval of 95% (95% CI) and as median and 1st and 3rd quartiles, in cases, that do not follow a normal distribution. Qualitative variables were expressed as percentages, with 95% Confidence Interval (CI). Incidence rate at 95% CI was calculated. For the comparison of quantitative variables, Unpaired t-test/Mann-Whitney test was used. For the comparison of qualitative variable, Fisher's-exact test/Chi-square test was used, as necessary.

RESULTS

Total 159 babies with a diagnosis of structural heart diseases were screened initially. Out of them, 111 babies were included, 53 in the PNE, and 58 in the NPEA group. In the PNE group, eight babies had congenital anomalies involving more than one system, whereas, nine in the NPEA group had multiple congenital anomalies, which were eliminated. In baseline demography, mean age of mother 26.59 years in the PNE group as compared to 26.65 years in the other group. Mean gestational age in the PNE group was 38.11 weeks, as compared to 38.39 weeks in the NPEA group. Overall, 27 (50.9%) babies of PNE group were delivered via lower segment caesarean section as against 17 (29.3%) of the NPEA group. Mean birth weight of the babies in the PNE and NPEA groups was 2.±0.4 kg and 2.73±0.46 kg, respectively.

Among babies with critical CHDs in PNE group, the requirement of inotropes was lesser compared to NPEA group (p-value=0.032). Among babies with minor CHDs in PNE group and NPEA group, the difference was not significant (p-value=0.272). In critical CHD, a significantly lesser number (22.6%) of babies in PNE group required ventilatory support on admission, whereas, it was 48.6% newborns in the NPEA group. In minor CHD the difference was not significant (p-value=0.272). No significant difference was observed in terms of metabolic acidosis in critical and minor CHDs of both groups [Table/Fig-2].

Variables	Type of CHD	PNE	NPEA	p-value
Ionotropes	Critical	8/31 (25.8%)	19/37 (51.4%)	0.032
	Minor	1/22 (4.5%)	3/21 (14.3%)	0.271
Need for ventilation	Critical	7/31 (22.6%)	18/37 (48.6%)	0.026
	Minor	1/22 (4.5%)	3/21 (14.3%)	0.272
Metabolic acidosis	Critical	23/31 (74.2%)	21/37 (56.8%)	0.134
	Minor	20/22 (90.9%)	16/21 (76.19%)	0.183

[Table/Fig-2]: Variables comparing critical and minor CHD of both groups.

The mean pH and HCO3 was similar in both the groups, but the pCO_2 and serum lactate were significantly high in the PNE group and

NPEA group, respectively [Table/Fig-3]. Comparison of outcome of critical (p-value=0.091) and minor CHDs (p-value=0.090) showed no significant difference [Table/Fig-4].

Group	Critical CHD		Minor CHD	
	Mean±SD	p-value	Mean±SD	p-value
pH				
PNE	7.31±0.090	0.279	7.38±0.042	0.286
NPEA	7.28±0.107		7.39±0.051	
HCO_3				
PNE	16.24±4.31	0.280	18.53±1.294	0.865
NPEA	15.12±4.13		18.68±3.586	
pCO_2				
PNE	35.08±9.00	0.032	37.42±4.085	0.021
NPEA	31.23±5.28		32.66±8.134	
Serum lactate				
PNE	3.49 (2.58)	0.019	1.96±0.995	0.452
NPEA	5.08 (2.79)		2.24±1.053	

[Table/Fig-3]: Variables in critical and minor CHD of both groups.

Outcome	Critical CHD n (%)			Minor CHD n (%)		
	PNE	NPEA	p-value	PNE	NPEA	p-value
Discharge against medical advice	8 (25.8%)	9 (24.3%)	0.091	0	5 (23.8%)	0.090
Discharge	9 (29.0%)	6 (16.2%)		20 (90.9%)	14 (66.7%)	
Transfer	12 (38.7%)	11 (29.7%)		1 (4.5%)	1 (4.8%)	
Death	2 (6.5%)	11 (29.7%)		0	1 (4.8%)	
Discharge on patient request	-	-		1 (4.5%)	0	
Total	31 (100%)	37 (100%)		22 (100%)	21 (100%)	

[Table/Fig-4]: Outcomes in critical and minor CHD of both groups.

DISCUSSION

The study aimed to find impact of prenatal diagnosis on the management and prognosis of infants with congenital heart disease, retrospectively. It showed that the newborns born in PNE group had significantly lesser requirement of inotropes and ventilation. There was statistical difference in pCO_2 levels and serum lactate in both groups.

PNE mean birth weight was 2.73±0.400 and NPEA mean birth weight was 2.75±0.463 kg; compared to the findings by Levey A et al., in which the prenatal diagnosed group also had a lower birth weight (3.0±0.6 vs 3.1±0.6 kg, p-value=0.002) [12]. The need of ventilation at time of admission in critical CHD in PNE group was less as compared to NPEA group. Landis BJ et al., also reported a lower odds of intubation in prenatally diagnosed CHD group [13]. Similarly, Peake LK et al., demonstrated that the risk of intubation were greater in the postnatal diagnosed, as compared to prenatally diagnosed, in which, population group was newborns with hypoplastic left heart syndrome and transposition of the great arteries [14]. A recent study by Thakur V et al., showed newborns with prenatal diagnoses were admitted earlier and were less likely to require preoperative ventilation [15].

In the present study, metabolic acidosis (pH≤7.25) in critical CHD was not statistical significance (p-value=0.134) in both groups. However, Peake LK et al., demonstrated, there was increase in the risk of metabolic acidosis in the postnatal period [14]. In the present study, among critical CHD, the need of inotropes in the prenatal diagnosis group was significantly lesser, than the other. Similarly, Thakur V et al., also reported a lesser need for ionotropic support (4/63 vs 15/61, p-value=0.006) than the postnatal cases [15].

In the present study, the outcomes were similar in both the groups (p-value=0.09). Chakraborty A et al., suggested that, the prenatal diagnosis of complex CHD was associated with significant reduction in the incidence of the following preoperative parameters in the form of use of antibiotics, mechanical ventilation, inotropic support, hepatic and renal dysfunction, and acidosis but there were no neonatal and infant survival benefits in association with prenatal diagnosis [16]. Similarly, Qiu X et al., also mentioned that there was no significant difference in survival rate between patients with simple CHD and those with complex CHD (p-value=0.101), but timely surgical management of infants with complex CHDs resulted in favourable outcomes [Table/Fig-5] [12-14,17].

Author name	Year of study	Population/Sample size	Major outcome variables
Levey A et al., [12]	2010	Of 439 neonates, 294 (67%) were Diagnosed Prenatally (PREdx), Infants who underwent surgical repair of CHD before discharge.	PREdx was associated with decreased preoperative intubation, antibiotics use, cardiac catheterisation and emergency cardiac surgery compared with POSTdx infants. There was no significant difference in preoperative pH, operative complications, hospital length of stay, or overall mortality in the PREdx vs POSTdx groups.
Landis BJ et al., [13]	2013	Among the 993 subjects, 678 (68.3%) had a prenatal diagnosis, haemodynamically significant CHD.	Prenatal diagnosis was associated with decreased need for invasive respiratory support. Prenatal diagnosis did not have an impact on preoperative or predischarge mortality.
Peake LK et al., [14]	2015	Total 52 cases of hypoplastic left heart syndrome or transposition of the great arteries.	The risk of intubation in the postnatal period was greater in cases of hypoplastic left heart syndrome or transposition of the great arteries diagnosed after birth when compared to those diagnosed antenatally. There was a no significant increase in the risk of metabolic acidosis in the postnatal period. No differences in mortality or long-term outcomes were demonstrated between antenatally and postnatally diagnosed cohorts.
Qiu X et al., [17]	2020	A total of 1492 foetuses with CHD were diagnosed by prenatal echocardiography from 67834 pregnant women. Infants were classified into four groups based on severity of cardiac abnormalities.	The survival rate of patients with simple CHD who underwent operation was 92.10%. There was no significant difference in survival rate between patients with simple CHD and those with complex CHD (p-value=0.101).

[Table/Fig-5]: Similar previous published studies [12-14,17].

Limitation(s)

The limitation of the present study is its small sample size.

CONCLUSION(S)

Prenatal diagnosis identified significant critical CHDs and it was linked to lower neonatal morbidity, including lesser need for inotropes, mechanical ventilation and emergency surgery. Prenatal diagnosis did not impact surgery, hospital stay, or mortality. Peculiarly, it helps in parental counselling and tertiary care delivery. Advanced prenatal awareness of a cardiac surgery, indication may allow for the optimisation of components in the form of newer techniques in neonatal resuscitation, stabilisation and intraoperative favourable outcome.

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