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Functional Echocardiography (FNECHO); Experience in NICU of A Tertiary Care Hospital

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ABSTRACT

Objective: To describe the observational findings of functional echocardiography (FnEcho) in neonatal intensive care unit of a tertiary care hospital by evaluating its frequency of use, characteristics of patients and distribution of heart diseases.

Methodology: This Prospective descriptive observational study was done in a tertiary neonatal intensive care unit (NICU) in Rawalpindi, from July 2017 to June 2018. A total of two hundred and twelve neonates admitted to the NICU undergoing echocardiographic assessment were included in the study. Qualitative variables like gender, mode of delivery, and diagnostic findings were represented in terms of frequency and percentages. Quantitative data like age, birth weight and gestational age were highlighted as mean and standard deviation.

Results: Out of a total of 212 neonates, 111 (52.4%) were male. The mode of delivery was noted to be lower segment cesarean section among 126 (60.0%) neonates. The mean gestational age was found to be 36.47+2.3 weeks, ranging from 28 to 41 weeks, whereas the mean birth weight was 2.56+0.68 kg, ranging from 1.1 to 4.2 kg. A total of 75 neonates were found to have functional heart disease in the form of pulmonary hypertension 37 (17.4%), hemodynamically significant patent ductus arteriosus 24(11.3%), hypoxic ischemic cardiomyopathy 4(1.9%), and systemic hypotension 10 (17.4%).

Conclusion: FnEcho was found to be an effective tool for identifying different kinds of functional and structural heart defects. VSD was found to be the most common type of congenital heart disease, followed by PDA. Timely intervention in PPHN was also rewarding with good outcome.

Keywords: Congenital heart disease, functional echocardiography, point of care ultrasound, cardiac ultrasound, Neonatal intensive care unit, FnEcho.

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Introduction

Echocardiography is performed in selected neonates to rule out any structural heart disease or assessment of cardiac function.[1] Usually it is performed to assess structural or functional integrity of the heart and the time at which it is performed is dependent on the availability of the pediatric cardiologist. The term functional echocardiography (FnEcho) is a relatively new term and has been described as utilization of echocardiography at the bedside by a qualified neonatologist or pediatrician in assisting decision making and evaluating hemodynamic characteristics of neonates who are thought to be at risk

for cardiac abnormalities. Evans N from Australia, was one of the pioneers in describing the term FnEcho.[2] Previously, echocardiography was supposed to be performed by pediatric cardiologists only. Now, with the increasing accessibility of ultrasound scanners in NICU and availability of trained neonatologists and pediatricians, though small in numbers, FnEcho is being performed in NICUs and plays a pivotal role in screening newborns for structural or functional heart diseases and making critical treatment decisions.[3,4] FnEcho can help identify structural heart diseases needing emergency interventions by the Peds cardiologist, determine the hemodynamic status of ductus arteriosus, diagnose pulmonary hypertension and make important management decisions in hemodynamically unstable neonates.[5]

In recent decades, new technologies like 3-dimentional echocardiography and color tissue Doppler imaging have revolutionized the diagnostic tools used for cardiac evaluation but variation in assessment tools and limited qualified professionals are some of the major factors found to impact epidemiology and existing patterns of cardiac defects among neonates throughout the world.[6,7] Studies from around the world have depicted FnEcho to be a useful tool in the assessment of neonates for hemodynamic instability and management.

This study was done to describe the findings of FnEcho in neonatal intensive care unit of a tertiary care hospital in Pakistan. We could not find any published data on the use of FnEcho in any Neonatal Intensive Care unit in Pakistan.

Methodology

This study was conducted in a large tertiary neonatal intensive care unit (NICU) in Rawalpindi, Pakistan from July 2017 to June 2018. Approval from the institutional ethical committee was taken. Written consent was sought from the parents/guardians of all study participants. A total of 212 neonates (aged from birth to 28 days) admitted to NICU, including indoor and outdoor admissions, in whom echocardiographic assessment was indicated, were included in this study. Indications for echocardiographic assessment included unexplained or prolonged tachypnea or oxygen dependency, cyanosis with or without feeding difficulty, presence of murmur, signs of congestive heart failure, preterm infants, pre and post ductal spO_2 more than 3%, associated anomalies like VACTER, VACTERL, cleft lip/palate, Features of Trisomy, congenital diaphragmatic hernia, TORCH infections, neonates with family history of CHD or babies born to diabetic mothers. All neonates who were unable to undergo echocardiographic assessment were not included in this study.

In difficult cases, an echocardiogram was performed by a trained pediatrician, and the results were confirmed by a paediatric cardiologist from the neighbouring paediatric cardiology unit (AFIC).All neonates who had patent foramen ovale and small PDA were considered normal as these are insignificant self-limiting disorders. Neonates having bicuspid aortic valve without the existence of aortic stenosis or aortic regurgitation or those who had mild pulmonary hypertension were taken as normal. If there was more than 1 cardiac lesion, the major lesion was considered as the main diagnosis.

Data was handled and analyzed using SPSS version 26.0. Qualitative variables like gender, mode of delivery and diagnostic findings were represented in terms of frequency and percentages. Quantitative data like age, birth weight and gestational age were highlighted as mean and standard deviation.

Results

Out of a total of 212 neonates, 111 (52.4%) were male. The mode of delivery was noted to be lower segment cesarean section among 126 (60.0%) neonates. The mean gestational age was found to be 36.47 ± 2.3 weeks (ranging from 28 to 41 weeks) whereas the mean birth weight was 2.56 ± 0.68 kg ranging from 1.1 to 4.2 kg. Table I shows the characteristics of neonates included in this study.

Table II shows the distribution of echocardiographic findings among neonates. Among the 107 (50.5%) neonates who were found to have structurally and functionally normal heart, 67 (31.6%) were having congenital heart disease while functional heart disease was found in 75 (35.3%) neonates. Persistent pulmonary hypertension, hemodynamically significant PDA, and systemic hypotension was found in 17.4%, 11.3% and 4.7% of the neonates respectively. In 10 (4.7%) neonates who had duct-dependent CHD, TGA with intact septum was the most frequent finding, seen in 4 cases followed by pulmonary atresia with intact septum in 3, critical coarctation of aorta in 2, critical aortic stenosis in 1 case.

Table III shows the distribution of various types of congenital heart disease found in 67 neonates in the

present study. Table IV shows the treatment modifications done in our patients after the findings of echocardiography. VSD was the commonest types of CHD noted in 17 (25.4%) neonates, followed by PDA, TOF and ASD in 10 (14.9%), 8 (11.9%) and 8 (11.9%) neonates, respectively.

Out of 105 patients, diagnosed with either structural or functional cardiac defects, treatment modification was required in 41.9% of the patients in the form of different management strategies as depicted in Table IV.

Table I: Characteristics of Study Participants (n=212)

Characteristics	N (%)
Gender	
Male	111 (52.4%)
Female	101 (47.6%)
Birth Weight (kg)	
<2.5	126 (59.4%)
≥2.5	86 (40.6%)
Gestational Age (weeks)	
<37	135 (63.7%)
≥37	77 (36.3%)
Mode of Delivery	
Spontaneous Vaginal Delivery	84 (40.0%)
Lower Segment Cesarean Section	126 (60.0%)

Table II: Distribution of Echocardiographic Findings among Neonates (n=212)

Diagnostic Findings		N (%)
Normal		107 (50.5%)
Functional Heart Disease (77)	Persistent Pulmonary Hypertension	37 (17.4%)
	Hemodynamically Significant PDA	24 (11.3%)
	Systemic Hypotension	10 (4.7%)
	Hypoxic Ischemic Cardiomyopathy	4(1.9%)
Structural Heart Disease (67)	Non-Duct Dependent CHD	67 (31.6%)
	Duct Dependent CHD	10 (4.7%)

Table III: Distribution of various types of congenital heart diseases (n=67)

Congenital Heart Disease	Number (%)
VSD	17 (25.4%)
ASD	8 (11.9%)
ASD + VSD	5 (7.5%)
PDA	10 (14.9%)
TOF	8 (11.9%)
Transposition of the Great Arteries with closing PDA	3 (4.5%)
Transposition of the Great Arteries with VSD and pulmonary stenosis	2 (3.0%)
Complete Atrioventricular Septal Defect	2 (3.0%)
Coarctation of Aorta	2 (3.0%)
Others	10 (14.9%)

Table IV: Treatment Modification in various Structural and Functional Heart Disease.

Treatment Modification	N(%)
Restriction of IV Fluids	89 (42%)
Addition of Ionotropic Support (Dopamine/Dobutamine)	33 (15.5%)
Addition of Diuretics	69 (32.5%)
Addition of Bosentan / Sildenafil / $MgSO_4$	44 (20.7%)
Digitalization	3 (1.4%)
Ibuprofen / Paracetamol	26 (12.2%)
Referral to Pediatric Cardiologist for emergency procedures	17 (8%)

Discussion

Many neonates with structural and functional cardiac problems are missed in our country due to a lack of access to echocardiography in NICUs. Studies from the developed world indicate increasing interest by physicians in the use of functional echocardiography (FnEcho) in neonatal units over the past two decades.[8] Limited data is available from the developing world regarding the impact of FnEcho on the management strategies among neonatal intensive care units. Studies from developed countries have shown modification of treatment ranging between 41-73.3% cases post FnEcho which shows that it proves very helpful among this set of neonates.[9-11] Prospective studies involving large sample size evaluating long term outcomes are needed to further verify what little is known about the impact of FnEcho. In a country like Pakistan, access to neonatal healthcare facilities and timely management of congenital heart diseases is still a big challenge for general population.

In the present study, FnEcho revealed that 49.5% of the suspected neonates were found to have functional or structural heart defects. 59.4% of the babies were low birth weight and 63.7% of the babies were preterm. This is comparable to the study done by Khamkar AM et al which showed that more preterm (60.43%) and low birth weight (75.4%) neonates undergo echocardiographic assessment.[12] Similarly study by Groves et al revealed that majority of the neonatal undergoing FnEcho were preterm and low birth weight.[9]

In the present study, the most frequently diagnosed functional problem was persistent pulmonary hypertension (PPHN), hemodynamically significant Patent Ductus Arteriosus (hsPDA), Systemic Hypotension and Hypoxic Ischemic Cardiomyopathy. In a similar Indian study, PPHN was found in 6.6%, hsPDA in 26.4% and systemic hypotension in 13.5% of the babies.[12] However, two Canadian studies revealed PDA (51% and 61% respectively) as the most common indication for FnEcho.[13,14]

FnEcho enabled us to provide a direct assessment of hemodynamic status of newborns and proved extremely valuable in making management decisions as mentioned in literature.[15-16] In an Indian study, changes in the management were done in 39.6% patients after FnECHO.[12] Similarly a Canadian study revealed treatment modification in 48% of the patients.[13] A study by Corredera et al[10] revealed that FnEcho modified treatment in 36.9% of the cases. Persistent pulmonary hypertension was found in most of our babies suffering from functional cardiac problems and benefitted the most from the timely introduction of Sildenafil, Bosentan and/or Magnesium sulphate (20.7%). Similarly, inotropes were timely started in the newborns suffering from different cardiac issues (15.5%). Hemodynamically significant PDA was identified in 24 patients, who were managed with fluid restrictions, diuretics and ibuprofen or paracetamol. Three babies were identified timely with Transposition of the Great arteries and closing PDA. They were timely referred to the neighboring cardiac unit for atrial septostomy, hence allowing timely intervention in those babies. These patients, once stable and off oxygen were referred to cardiac unit for detailed assessment. Few patients needed urgent transfer to neighboring Pediatric Cardiology unit for Life saving interventions like Arterial Switch Operation or Atrial Septostomy.

In the present study, we observed VSD to be the commonest types of CHD noted in 25.4% neonates while PDA, TOF and ASD were noted in 14.9%, 11.9% and 11.9% neonates, respectively. Our findings are consistent with the previously published study done by Hussain S and colleagues where they noted VSD is the commonest form of congenital heart disease, noted among 31% of cases, along with ASD, PDA and TOF among 22.9%, 14.9% and 6.9% cases respectively.[17]

Conclusion

FnEcho was found to be an effective tool for identifying different kinds of functional and structural heart defects. We were able to timely initiate various treatment strategies (as mentioned earlier), in a rather crowded and busy NICU, thus reducing morbidity and mortality. We need to focus on training young neonatologists in the field of echocardiography. This will not only reduce the burden on busy cardiac units but also help our perishing neonates survive better.

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