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ORIGINAL ARTICLE

To Observe the Effect of Bi-ventricular Systolic and Diastolic Function in Neonates with Varying Degree of Pulmonary Hypertension

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ABSTRACT

Objective: To evaluate bi-ventricular systolic and diastolic function in neonates with varying degree of pulmonary hypertension through echocardiography.

Study Design: A cross-sectional study using convenience-sampling technique.

Place and Duration of Study: Department of Pediatric Cardiology, The Children's Hospital and the Institute of Child Health, Lahore from October 2019 for 6 months

Material and Methods: We used a proforma as a data-collecting tool. The Institutional review board (IRB) and parent's consent taken. All the data entered in SPSS version 25 and then analyzed for statistically significant outcomes. Descriptive analysis used to describe the basic features of the data through Pearson correlation.

Results: Out of 73 patients, 63 were male and 10 were female. Mild pulmonary hypertension was present in 26% babies, moderate pulmonary hypertension detected in 24% babies and severe pulmonary hypertension detected in 49% neonates. Neonates with mild and moderate pulmonary hypertension showed 12% LV dysfunction while neonates with severe pulmonary hypertension 29% of these neonates had LV dysfunction.

Neonates with mild pulmonary hypertension revealed that 36% had severe RV dysfunction and babies with moderate pulmonary hypertension 76% of them showed moderate to severe RV dysfunction. In category of severe pulmonary hypertension, 80% of babies were detected moderate to severe RV dysfunction.

Conclusion: LV and RV dysfunction is significantly high with different degree of pulmonary hypertension in neonates. Hence, focus should made towards RV and LV function while evaluating these neonates for adequate management regarding pulmonary hypertension.

Key Words: Neonates, Pulmonary hypertension, Ventricular systolic dysfunction , Ventricular diastolic dysfunction

INTRODUCTION

Pulmonary hypertension in newborn is actually lethal. High pulmonary pressures cause right-to-

left shunt, hypoxemia and RV failure.¹ The frequency is 1.9 per 1000 live births with 11% mortality.² Neonates with severe illness may need

progressive ICU care with advance treatment.^{3,4} Echocardiography is an ideal non-invasive tool for detecting and observing PPHN, in spite of an absence of reliable measures.^{5,6}

However, many factors for assessment through echocardiography reveal poor accuracy which matched with catheterization.⁷ These measures in severe PPHN may have reduced cardiac function secondary to hypoxia and RV dysfunction.⁸ Tricuspid annular plane systolic excursion (TAPSE) and fractional area change (FAC) are recently used for RV assessment in children.⁹

The rationale of our study is to assess bi-ventricle systolic and diastolic function in neonates with various degree of severity of pulmonary hypertension through non-invasive technique that is echocardiography. Very few studies demonstrate the effect of right and left ventricular both systolic and diastolic function with various degree of pulmonary hypertension. Identifying systolic as well as diastolic dysfunction early will help the neonatologist to incorporate the strategies to tackle pulmonary hypertension in a proper systematic way at proper time to reduce the mortality.

MATERIAL AND METHODS

It was a cross-sectional study using convenience-sampling technique. Proforma as a data-collecting tool made. Data collected from the Department of Pediatric Cardiology, The Children's Hospital and the Institute of Child Health, Lahore, after the approval of institutional review board (IRB) with parent's consent from October 2019 for 6 months.

Inclusion criteria: Neonates less than 28 days of life, having persistent low saturation and tachypnea, oxygen dependant or having sign of persistent cardiac failure were included in the study. Those having labelled as transient tachypnea of newborn (TTN), birth asphyxia grade 1 and 2, congenital pneumonia, early sepsis and meconium aspiration were included in study.

Exclusion criteria: Neonates with congenital pneumonia, pneumothorax, diaphragmatic hernia, severe birth asphyxia (ANN-3), ventilated babies, premature less than 32 weeks and having congenital heart diseases other than patent foramen ovale (PFO) and patent ductus arteriosus (PDA) were excluded from the study.

Echocardiography: The transthoracic echocardiography images get from apical four-and two-chamber views and parasternal short-axis views, using a General Electric (GE) E95 system. Results of 3-5 cardiac cycles recorded to account for beat-to-beat variability. We recorded the following variables like Inter-ventricular septum deviation, right ventricular diastolic dimension, (TAPSE) tricuspid annular plane systolic excursion, E-prime ,E-waves, A-waves and (DT) de-acceleration time systolic and diastolic function of RV and LV noted on the performa of each patient.

From the apical four-chamber view, pulsed-wave tissue doppler imaging (TDI) was performed at the lateral and septal mitral annulus, and the lateral tricuspid annulus; peak early E' and late A' diastolic myocardial annular velocities and isovolumic relaxation time (by TDI of the lateral mitral annulus) were recorded. Three to five cycles recorded for the assessment of parameters to minimize the false reading. Only echocardiography reports by pediatric cardiologists were entered in the study.

Statistical Analysis: All the data entered in SPSS version 25 and then analyzed for statistically significant outcomes. Descriptive analysis used by the Pearson Correlation and chi-squared applied.

RESULTS

Out of 73 patients, 63 were males and 10 were females (fig 1). 19 patients had labelled mild pulmonary hypertension, 18 patients had moderate pulmonary hypertension, and 36 patients had severe pulmonary hypertension shown in fig 2 with ranges. On the basis of tricuspid regurgitation and direction of flow of PFO and inter-atrial septal bowing toward left there were 31% babies showed pulmonary hypertension up to 7 days of life where as 24.6% babies having pulmonary hypertension having age up to 14 days and 45% babies fall on above 14 days of life (table 1).

RV and LV systolic and diastolic function were assessed on the basis of inter-ventricular septum deviation, right ventricular diastolic dimension, (TAPSE) tricuspid annular plane systolic excursion, e-Prime ,E-waves, A-waves and (DT)

de-acceleration time , MAPSE and categorized into mild ,moderate and severe dysfunction according to standard valve of the American Society of Echocardiography recommendation as documented in table 2 and 3.

TABLE 1: Cross tab of age and pulmonary hypertension

	Count				
	Severity of pulmonary hypertension			Total	
	Mild	Mod- er- ate	Severe		
Age (days)	1-7 days	9	3	10	22
	8-14 days	4	8	6	18
	Above 14 days	6	7	20	33
Total	19	18	36	73	

Table 2: Echocardiographic parameters for RV function:

RV Echo Parameters				
	Mean	Range	St. deviation	Skew- ness
IVS deviation	1.3158	1	0.4775	0.862
RVDd	11.3684	2	0.7608	-0.771
TAPSE	10.6316	7	2.2903	0.973
E wave	0.5763	0.13	0.5252	-0.557
A wave	0.3874	0.24	0.0789	-0.149
E' wave	0.1747	0.43	0.1729	1.53
DT	116.474	57	21.1486	0.363

IVS=Inter-ventricular septum, **RVDd** =Right ventricular diastolic dimension, **TAPSE**=Tricuspid annular plane systolic excursion, **E'**=E-Prime, **DT**=De-acceleration time

TABLE 3: Echocardiographic parameters For LV function

	LV Echo Parameters			
	Mean	Range	St.deviation	Skewness
LVDd	16.2778	2	0.7519	-0.529
IVS deviation	5.5	3	1.42457	0.069
MAPSE	9.2222	4	1.4775	1.048
E wave	0.6717	0.29	0.11079	-0.781
A wave	0.4822	0.16	0.06301	0.682
E' wave	0.35	0.45	0.46757	1.46
DT	124.833	57	22.9968	-0.211

LVDd=Left ventricular diastolic dimension, **IVSd**=Inter-ventricular septum **MAPSE**=Mitral annular plane systolic excursion, **E'**=E- Prime, **DT**=De-acceleration time

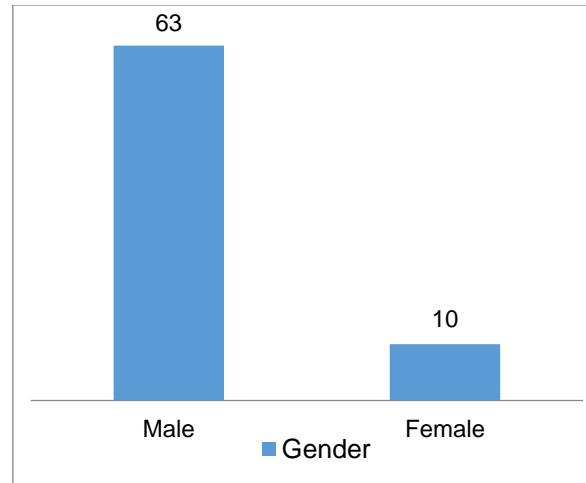


Fig 1: Gender

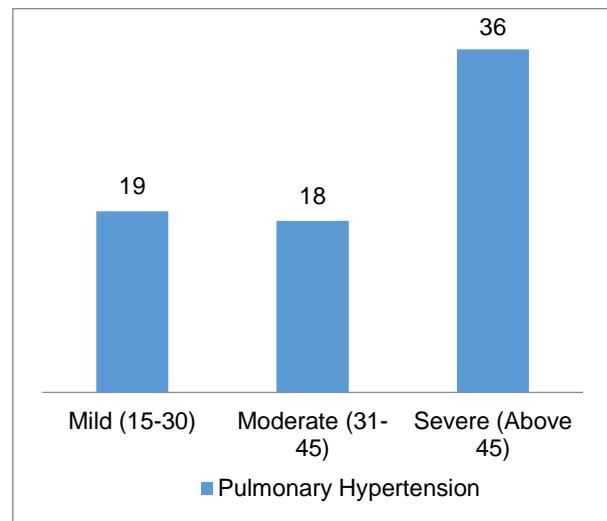


Fig 2: Pulmonary hypertension

Regarding left ventricular dysfunction 9.4% (n=7) babies found to be mild LV dysfunction with severe pulmonary hypertension while 5.4% (n= 4) had moderate LV dysfunction (table 4). On the contrary significant right ventricular dysfunction with different level of pulmonary hypertension

noted 5.4% (n=4) babies revealed mild RV dysfunction with different level of Pulmonary hypertension, 61% (n=45) showed moderate RV dysfunction and 24.6% (n=29) babies had severe RV dysfunction with different level of Pulmonary hypertension (table 5).

TABLE 4: LV diastolic function with different degree of pulmonary hypertension

		Severity of Pulmonary Hypertension			Total
		Mild	Moderate	Severe	
Severity of LV systolic function	Normal (12-9mm MAPSE)	19	18	25	62
	Mild dysfunction (7mm MAPSE)	0	0	7	7
	Moderate dysfunction (4mm MAPSE)	0	0	4	4
	Severe dysfunction (<4mm MAPSE)	0	0	0	0
Total		19	18	36	73

TABLE -5: RV diastolic function with different degree of pulmonary hypertension

		Severity of pulmonary hypertension			Total
		Mild	Moderate	Severe	
Severity of RV diastolic function	Normal (E/A 0.75-1.5, DT >140ms)	3	0	3	6
	Mild dysfunction (E/A <1.5, DT>230ms)	0	4	0	4
	Moderate dysfunction (E/A 0.75<1.5, DT<140ms)	9	7	29	45
	Severe dysfunction (E/A >1.5, DT<140ms)	7	7	4	18
Total		19	18	36	73

DISCUSSION

Majority of studies emphasize RV systolic dysfunction in PH, and some study highlight LV diastolic dysfunction in pediatric PH.¹⁰ In many cardiovascular conditions, diastolic dysfunction is a significant determinant of outcomes.¹¹ Similarly, biventricular dysfunction likely result the worse outcomes.¹² In this study we found that RV diastolic function effected badly as compare to LV diastolic function with severity of pulmonary hypertension in neonates. Abdel Massih et al in their study revealed ventricular functions in newborns with PPHN and to determine whether short-term outcome is closely related or not to ventricular dysfunction occurring in PPHN. LV functions results in highest prediction of negative outcome in cases with PPHN than RV Tei-index.¹³ Therefore our study supported that in case of severe pulmonary hypertension bi-ventricular diastolic dysfunction worsen the outcome of neonates. It presume that if we pick early the diastolic dysfunction by non-invasive method we can reduce the mortality of the neonates. Marten revealed that left ventricular dysfunction may be a common feature in neonates with PPHN and may be detected using echocardiograms.¹⁴ Systolic: diastolic ratio has been associated with clinical

outcomes in older children with pulmonary hypertension, but it has not been studied in infants with PPHN. This measure is a complex interplay of RV contractility, preload, afterload, and heart rate.¹⁵ We tried to find the co-relation of both ventricular diastolic function so that we can be able to predict the outcome in neonates.

The purpose of selecting this study was, as single echocardiographic parameters are not reliable for assessment of ventricular function in neonates with PPHN. Therefore multiple echocardiographic parameters used for assessment of ventricular function and emphasis both on systolic as well as diastolic function and see the result of pulmonary hypertension. inspite of advancement in echocardiography still neonatal hypertension and ventricular function to define outcome is still not clear.

Limitations: This was single center study with wide range of presentation in neonates with no prenatal record. Being a reference center and all neonates delivered outside hospital, very sick children could not assessed in this study. Similarly, we could not assess the outcome and management. There is limitation also because we could not compare PH with hemodynamic assessment to rule out load dependent measures

.Strain and 3-D assessment could not done because of highly technology dependency.

CONCLUSION

RV diastolic dysfunction is significantly high than LV diastolic dysfunction with different degrees of pulmonary hypertension in neonates. Hence, for adequate management regarding pulmonary hypertension focus should made towards bi-ventricular systolic as well as diastolic function while evaluating these neonates through echocardiography.

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