

# FUNCTIONAL ECHOCARDIOGRAPHY IN ASSESSMENT OF THE CARDIOVASCULAR SYSTEM IN PERINATAL ASPHYXIATED TERM NEONATES WITH NON ASPHYXIATED TERM NEONATES

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## ABSTRACT

**Background & objectives:** Perinatal asphyxia usually refers to the condition of impaired gas exchange during the first and second stage of labor, that if persist leads to fetal hypoxemia and hypercarbia. This study aimed to compare functional echocardiographic parameters of perinatal asphyxiated term neonates with non asphyxiated term neonates. **Methods:** This study focused on perinatal asphyxia and hypoxic ischemic encephalopathy (HIE). Perinatal asphyxia was diagnosed based on criteria from the NNPD network, with moderate cases showing slow/gasping breathing or an APGAR score of 4 to 6 at 1 minute, and severe cases showing no breathing or an APGAR score of 0-3 at 1 minute. **Results:** In study group LA is not significant. Mean Ao is Not statistically significant. LA/Ao Ratio (p value = 0.01), suggestive of left atrial enlargement due to mitral regurgitation associated with birth asphyxia in neonates. LVED Measurements are not statistically significant. LVES statistically significant. EF and FS were significantly affected in the study group. LVMPI and mVCF not influenced by birth asphyxia, statistically insignificant. RVED, RVES, MAPSE and TAPSE are not influenced by birth asphyxia, statistically insignificant. **Conclusion:** These findings underscore the impact of perinatal asphyxia on cardiac function and highlight the importance of monitoring and intervention in affected neonates.

**Key words:** Perinatal asphyxia, APGAR score, hypoxic ischemic encephalopathy

## INTRODUCTION

Perinatal asphyxia usually refers to the condition of impaired gas exchange during the first and second stage of labor, that if persist leads to fetal hypoxemia and hypercarbia.<sup>1</sup> (Basic Newborn

Resuscitation Practical Guideline from WHO). National Neonatal Perinatal

Database (NNPD) 2000 defined moderate asphyxia as slow gasping breathing or an APGAR score of 4-6 at 1 minute of age. Severe asphyxia was defined as absent breathing or an APGAR score of 0-3 at 1 minute of age.<sup>2</sup>

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Hypoxic ischemic encephalopathy (HIE) is defined as “an acute non static encephalopathy caused by intra partum or late ante partum brain hypoxia and ischemia. It evolves during the first day of life and is a leading predictor of neuro developmental disability.<sup>3</sup> HIE is classified by modified Sarnat and Sarnat classification<sup>4</sup>, the Levene’s classification and / or the Thompson scoring. The various clinical features related to cardiac dysfunction are increase in respiratory rate, hepatomegaly, hypotension due myocardial dysfunction and systolic murmur (usually pan-systolic murmur of tricuspid regurgitation and/or mitral regurgitation) because of annulus dilatation of papillary muscle necrosis.<sup>5</sup>

Respiratory distress is the most important clinical feature of hypoxic heart damage. Functional echocardiography (Fn Echo) is the bedside diagnostic tool to longitudinally assess myocardial function, systemic and pulmonary blood flow, intra and extra cardiac shunts.<sup>6,7</sup> The clinical evaluation, cardiac enzymes – LDH, CPK-MB and troponin, electrocardiography (ECG), echocardiogram- M mode, 2D ECHO, Doppler and tissue doppler are means for cardiac function evaluation are the different modalities to evaluate neonate with birth asphyxia.<sup>8,9</sup> This study aimed to compare functional echocardiographic parameters of perinatal asphyxiated term neonates with non asphyxiated term neonates.

## MATERIALS AND METHODS

The study, conducted in the Division of Pediatric Cardiology at M.D.M Hospital under the Department of Pediatrics, Dr. S. N. Medical College, Jodhpur, was observational and approved by the Institutional Ethical Committee. It focused on perinatal asphyxia and hypoxic ischemic encephalopathy (HIE). Perinatal

asphyxia was diagnosed based on criteria from the NNPD network, with moderate cases showing slow/gasping breathing or an APGAR score of 4 to 6 at 1 minute, and severe cases showing no breathing or an APGAR score of 0-3 at 1 minute. HIE was diagnosed through physical examination, including assessments of consciousness level, reflexes, and other factors.

The study included term babies meeting specific criteria and excluded those with certain conditions like congenital malformations or positive perinatal septic scoring. Sample size calculation yielded 60 as the predicted sample size. In the asphyxiated group, neonates were admitted to the NICU and managed according to standard guidelines.

Various parameters, including Apgar score, gestational age, and weight, were recorded. Gestational age was assessed using different methods, including the Expanded New Ballard score. Sarnat & Sarnat staging was used to grade the severity of HIE within six hours of birth. Blood chemistry tests, clinical examinations, and neurological assessments were conducted within 6 hours of birth. Functional echocardiography (FnECHO) was performed within specific timeframes using designated equipment and views, and parameters were recorded on a pre-designed form. The scans were conducted by a paediatric cardiologist.

## RESULTS

The male to female ratio in control and study group were 0.96:1 and 0.95:1 respectively. The mean birth weight of the neonates in control group and study group were  $2.98 \pm 0.32$  kg and  $2.82 \pm 0.31$  kg respectively. (Table 1)

**Table 1: Gender and weight wise distribution of study subjects**

Gender	Control group (n=65)	Study group (n=45)
Male	32 (49.23%)	22 (48.89%)
Female	33 (50.77)	23 (51.11%)
Total	65	45
Weight (in kg)	Control group (n=65)	Study group (n=45)
< 2.5 kg	03	06
>2.5	62	39
Total	65 (2.98±0.32)	45 (2.82±0.31)

In HIE I group, the mean values of CPKMB and LDH were  $124.33\pm93.47$  and  $579.0\pm163.58$ , respectively. Notably, none of the cases tested positive for troponin I. Moving to HIE II group, the mean values of CPKMB and LDH were notably higher at  $264.28\pm179.72$  and  $772.0\pm440$ , respectively. In the most severe category,

HIE III, the mean values of CPKMB and LDH further increased to  $439.54\pm156.73$  and  $1382.12\pm367.37$ , respectively. Here, a significant proportion of cases, 10 out of 11, tested positive for troponin I, suggesting a pronounced cardiac impact in this group. (Table 2)

**Table 2: Biomarker level with severity of HIE grading**

HIE Grading	CPKMB	TROP I (+)	Serum LDH
I [n=9]	$124.33\pm93.47$	--	$579.0\pm163.58$
II [n=25]	$264.28\pm179.72$	05	$772.0\pm440.66$
III [n=11]	$439.54\pm156.73$	10	$1382.12\pm367.37$

In our study group, we meticulously evaluated various parameters associated with left ventricular systolic function. The mean (La) was  $10.99\pm2.19$ mm, and the mean (Ao) was  $8.93\pm1.03$ mm, resulting in a mean La/Ao ratio of  $1.23\pm0.27$ . Additionally, the mean LVED was  $15.63\pm2.11$ mm, while the mean LVES was  $11.14\pm2.59$ mm. Key functional indices like LVFS and LVEF were  $24.93\pm7.57\%$  and

$45.24\pm13.14\%$ , LVMPI was measured at  $0.53\pm0.51$ . Furthermore, parameters such as mitral valve velocity, mitral annular plane systolic excursion, and E/a ratio were thoroughly assessed. These comprehensive findings offer valuable insights into left ventricular systolic function within the study group, enhancing our understanding of cardiac dynamics in this context. (Table 3)

**Table 3: Left ventricular systolic and diastolic functions of study group (n = 45)**

Parameters	Mean ± SD	95% CI
La	$10.99\pm2.19$	10.33-11.65
Ao	$8.93\pm1.03$	8.62-9.24
La/Ao	$1.23\pm0.27$	1.15-1.32
LVED	$15.63\pm2.89$	15.12-16.06
LVES	$11.14\pm2.59$	10.36-11.92

<b>EF</b>	45.24±13.14	41.29-49.19
<b>FS</b>	24.93±7.57	22.65-27.21
<b>LVMPI</b>	0.53±0.51	0.48-0.69
<b>Mvcf</b>	1.50±0.68	1.29-1.71
<b>MAPSE</b>	4.56±0.92	4.28-4.84
<b>Diastolic functions</b>		
<b>Parameters</b>	<b>Mean ± SD</b>	<b>95% CI</b>
<b>Mitral E/A</b>	1.14±0.33	1.04-1.24
<b>E/e' Medial</b>	9.18±2.10	9.94-12.65
<b>E/e' Lateral</b>	9.34±1.5	9.26-11.10

In our study group, we meticulously assessed several parameters related to right ventricular function. The mean RVDD was 9.49±1.73mm, while the mean RVDs was 5.36±1.73mm. TAPSE was measured at 5.76±1.32mm, indicating the systolic function of the tricuspid valve. The E/a

ratio of the tricuspid valve was 1.09±0.41, suggesting the ratio of early to late diastolic filling velocities. Tricuspid valve annular velocities were evaluated at both the medial and lateral valves, with velocities of 9.70±1.37cm/sec and 9.28±1.18cm/sec, respectively. (Table 4)

**Table 4: Right Ventricular Systolic and Diastolic functions in study group (n=45)**

<b>Parameters</b>	<b>Mean ± SD</b>	<b>95% CI</b>
<b>RVDD</b>	9.49±1.73	8.96-10.01
<b>RVDs</b>	5.36±1.73	4.84-5.88
<b>TAPSE</b>	5.76±1.32	5.36-6.16
<b>Diastolic functions</b>		
<b>Parameters</b>	<b>Mean±SD</b>	<b>95% CI</b>
<b>Tricuspid E/A</b>	1.09±0.41	0.97-1.22
<b>E/e'medial</b>	9.70±1.37	8.98-10.41
<b>E/e'Lateral</b>	9.28±1.18	7.83-9.14

The mean value of Tricuspid annulus and Mitral annulus in control group were 13.86±2.06mm and 11.26±1.37mm with 95% confidence limit 13.09-13.82 and 10.85-11.68 respectively. In our study group, The MR across the mitral valve was measured at 205.57±79.02, with a 95% confidence limit ranging from 159.95 to 251.14. Similarly, TR was found to have a

mean value of 255.63±84.57, with a 95% confidence limit between 227.82 and 283.45. For the pulmonary valve, the mean regurgitation was 149.18±62.40, with a 95% confidence limit ranging from 107.26 to 191.10. Lastly, regurgitation across the aortic valve had a mean value of 168.0±22.82, with a 95% confidence limit between 142.59 and 193.41. (Table 5)

**Table 5: Annular diameter of AV valve and Regurgitation across AV and semilunar Valves in study group (n=45)**

<b>Parameters</b>	<b>Mean ± SD</b>	<b>95% CI</b>
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<b>Tricuspid annulus</b>	13.8±2.06	13.09-13.82
<b>Mitral annulus</b>	11.26±1.37	10.85-11.68
<b>Regurgitation across AV and semilunar Valves</b>		
<b>Parameter</b>	<b>Mean ± SD</b>	<b>95% CI</b>
<b>MR</b>	205.57±79.02	159.95-251.14
<b>TR</b>	255.63±84.57	227.82-283.45
<b>PR</b>	149.18±62.40	107.26-191.10
<b>AR</b>	168.0±22.82	142.59-193.41

## DISCUSSION

In the present study total 65 healthy term neonates in the control group and 45 neonates with birth asphyxia in the study group were enrolled. Functional echocardiographic parameters were compared in both groups. The male to female ratio in control and study group were 0.96:1 and 0.95:1 respectively( Fig 1).The mean birth weight of the neonates in control group and study group were 2.98 ± 0.32 kg and 2.82±0.31 kg respectively. In our study out of total 45 cases in study group, 12(26.66%) cases expired and 33(73.33%) survived. Among expired cases 8.3 % and 91.66 % cases were in HIE II and HIE III group respectively. In study group mean value of La was 10.99±2.19mm while in control group 10.52±1.73mm which was statically not significant. The mean value of Ao in study group was 8.93±1.03mm while in control group was 9.49±1.00mm.

The mean value of La/ Ao in study group was 1.23±0.27 while in control group was 1.11±0.22 which was statically significant(p value 0.01), suggestive of Left atrial enlargement because of Mitral regurgitation associated left atrial enlargement in neonates with birth asphyxia. The mean value of LVED in the study group was 15.63±2.11mm while in control group was 14.99±2.89mm which was not statistically significant.

The mean value of LVES in study group was 11.14±2.59mm while in control group was 9.94±2.08mm which was statically significant(p value 0.008). Tsivyan PB and Vasenina AD et al10 reported from their study value of LVED and LVES in control group as 17.7±1.5mm and 10.2±1.2mm respectively while in study group as 18.9±1.6mm and 12.5±1.4mm which was statically significant(<0.05).

The mean value of EF and FS in study group was 45.24±13.14 and 24.93±7.57 respectively while in control group was 64.95±10.08 and 36.43±8.07. It suggest among neonates with birth asphyxia EF and FS were affected, which was confirmed statically also, as P value was <0.0001.Tsivyan PB and Vasenina AD et al6 reported from their study value of fractional shortening (LVFS) in study group was 33.8±5.2% while in control group was 41.0±6.9% which was statically significant(<0.001).

The mean values of LVMPI and mvcf in the study group were 0.53±0.51 and 1.50±0.68 while in the control group were 0.48±0.32 and 1.69±0.59. It means among neonates with birth asphyxia LV MPI and mVCF were not influenced, which was confirmed statically also, as P value was >0.05 which were not significant.

The mean value of mitral E/A, medial and lateral E/e' among study and control group

were  $1.14 \pm 0.33$ ,  $9.18 \pm 2.10$  &  $9.34 \pm 1.5$  and  $1.14 \pm 0.29$ ,  $8.34 \pm 2.73$  &  $8.72 \pm 1.98$  respectively. It means among neonates with birth asphyxia the mean value of mitral E/A, medial and lateral E/E' were not influenced, which was confirmed statically also, as P value was  $>0.05$  which were not significant.

The mean values of RVED and RVES in the study group were  $9.49 \pm 1.73$ mm and  $5.36 \pm 1.73$ mm respectively while in the control group were  $8.83 \pm 1.80$ mm and  $4.92 \pm 1.54$ mm respectively. It means among neonates with birth asphyxia the mean value of RVED and RVES were not influenced, which was confirmed statically also, as P value was  $>0.05$  which were not significant.

The mean value of MAPSE and TAPSE in study group were  $4.56 \pm 0.92$ mm and

$5.76 \pm 1.32$ mm respectively while in control group were  $4.65 \pm 1.04$ mm and  $6.05 \pm 1.61$ mm respectively. It means among neonates with birth asphyxia the mean value of MAPSE and TAPSE were not influenced, which was confirmed statically also, as P value was  $<0.05$  which were not significant.

The mean value of tricuspid E/A, medial and lateral E/e' were  $1.09 \pm 0.41$ ,  $10.70 \pm 2.37$  &  $9.48 \pm 2.18$  respectively while in control group were  $0.92 \pm 0.34$ ,  $8.72 \pm 2.30$  and  $8.37 \pm 2.02$  respectively. It means among neonates with birth asphyxia the mean value of tricuspid E/A, medial and lateral E/E' were not influenced, which was confirmed statically also, as P value was  $>0.05$  which were not significant.

#### Following Echo parameters were influenced by perinatal asphyxia

Parameters	Study group	P value
<b>EF</b>	$45.24 \pm 13.14$	$<0.0001$
<b>FS</b>	$24.93 \pm 7.57$	$<0.0001$
<b>LVES</b>	$11.14 \pm 2.59$	0.008
<b>La/Ao</b>	$1.23 \pm 0.27$	0.014
<b>RVDD</b>	$9.49 \pm 1.73$	0.048
<b>Tricuspid diastolic annular Diameter</b>	$13.8 \pm 2.06$	0.0005

#### Following Echo parameters were not influenced by perinatal asphyxia

Parameters	Study group	P value
<b>LVED</b>	$14.99 \pm 2.89$	0.184
<b>La</b>	$10.99 \pm 2.19$	0.208
<b>LVMPI</b>	$0.53 \pm 0.51$	0.530
<b>Mvcf</b>	$1.50 \pm 0.68$	0.136
<b>MAPSE</b>	$4.56 \pm 0.92$	0.638
Parameters	Study group	P value
<b>Mitral E/A</b>	$1.14 \pm 0.33$	0.971
<b>E/e' Medial</b>	$9.18 \pm 2.10$	0.168
<b>E/e' Lateral</b>	$9.34 \pm 1.5$	0.766

<b>RVDs</b>	5.36±1.73	0.166
<b>TAPSE</b>	5.76±1.32	0.323
<b>E/e'medial</b>	9.70±1.37	0.206
<b>E/e'Lateral</b>	9.28±1.18	0.790
<b>Mitral annulus</b>	11.26±1.37	0.175

The mean value of tricuspid and mitral annulus in study group were  $13.8\pm2.06$ mm and  $11.26\pm1.37$ mm respectively while in control group were  $12.43\pm1.53$ mm and  $9.62\pm1.31$ mm respectively. It means among neonates with birth asphyxia the mean value of diastolic diameter of tricuspid annulus was influenced.

## CONCLUSION

The study revealed significant differences between perinatal asphyxiated neonates and control groups in various cardiac parameters. Notably, LVES, EF, FS, RVED, and tricuspid annulus measurements showed statistically significant differences between the two groups. Additionally, elevated levels of CPKMB were associated with abnormalities in EF, FS, MAPSE, TAPSE, La/Ao, La, RVES, RVED, LVES, and tricuspid annulus. These findings underscore the impact of perinatal asphyxia on cardiac function and highlight the importance of monitoring and intervention in affected neonates.

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