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Original Research Article

Significance of ECG in Different Stages of Birth Asphyxia and its Correlation with Cardiac Troponin-I

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Abstract

This observational study was carried out in the department of Paediatric Medicine and NICU of Dhaka Shishu Hospital during the period of July'2015 to June'2017. The main objective of this study was to observe the Significance of ECG changes in different stages of birth asphyxia and its correlation with Cardiac Troponin-I. A total of 75 neonates diagnosed as perinatal asphyxia with different stages of Hypoxic Ischemic Encephalopathy. Among the total 75 cases, ECG changes were seen in 32(42.66%) patients, remaining 43 babies had no change in ECG. Maximum changes were noticed among the cases with HIE stage-III 21(28.00%), followed by HIE stage-II 10(13.33%) and Stage-I 1(1.33%). Most common type of ECG abnormality was Grade-II changes which was present in 16 patients. This was followed by Grade-III type of changes, found in 9 patients and Grade-I type seen in 7 patients. No significant difference was seen among the neonates with HIE Stage-I, HIE stage-II and HIE stage-III groups with respect to parameters like birth weight, sex, gestational age, crown heel length (CHL), occipital frontal circumference (OFC), maternal age, and antenatal complications. Measurement of serum cardiac troponin I and determination of Myocardial performance index (Tei index), both are effective in assessment of myocardial dysfunction in asphyxiated neonates with HIE. Pearson's Correlation Coefficient (r) test was done to see whether the two methods correlate in diagnosing myocardial dysfunction. Thorough clinical examination done with special attention to heart rate, blood pressure, and capillary refill time at admission and followed up till discharge or death. Blood pressure (systolic) was measured by auscultatory or flush method and plotted on blood pressure chart, capillary refill time (CRT) assessed by giving pressure over the sternum.

Keywords: Paediatric, Asphyxiated, Cardiac, asphyxia, Myocardial, Encephalopathy.

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INRTODUCTION

Cardiac dysfunction is well known in perinatal asphyxia caused by transit myocardial ischemia. Sometimes cardiac dysfunction may be so severe that it can cause congestive cardiac failure and shock that leads to death of newborn. ECG and serum levels of cardiac enzymes can be used to demonstrate impaired myocardial function. Perinatal Asphyxia (PA) is defined as a failure to initiate and sustained breathing at birth, and is an insult to fetus or newborn due to the lack of oxygen (Hypoxia) and/or a lack of perfusion (ischemia) to various organs which will manifest as difficulty in establishing spontaneous respiration evident by a delayed crying after birth. Though, there are important advances in perinatal care in the past few decades, perinatal asphyxia remains a severe condition leading to significant mortality and morbidity. PA has an incidence of 4.6—26 per 1,000 live full-term births. It represents the third most common cause of neonatal death. Perinatal asphyxia results in multi-organ damage, where cardiovascular dysfunction is a frequent association. The incidence of cardiovascular dysfunction increases with the severity of neurological damage. Echocardiography offers detail information to assist the clinician in identifying significant cardiovascular impairment, and thus can help in appropriate management plan. Hypoxic-ischemic encephalopathy (HIE) is the most common neurologic complication in the perinatal period. HIE develops in the setting of perinatal asphyxia, and is a multi-organ system disease. Hypoxia and ischemia can cause damage to almost every tissue and organ of the body [1]. In developed countries, the incidence of severe perinatal asphyxia (causing death or severe neurological impairment) is about 1/1000 live births. In resource-poor countries, perinatal asphyxia is probably more

common. Data from hospital-based studies in such settings showed the incidence 5–10/1000 live births. This is probably an underestimation of the true community incidence [2]. Prevalence of perinatal asphyxia varies greatly among different countries, in a study at Nepal it was estimated to be 26.9/1000 live births[3].Immediate morbidity and mortality of perinatal asphyxia is due to multi-organ dysfunction. Involvement of one or more organs occurred in about 82% infant. The central nervous system (CNS) is the organ most frequently involved (72%). Percentage of other organ involvement are as follows: Renal involvement occurred in 42%, Cardiac involvement in 29%, Pulmonary involvement in 26%, and GIT involvement in 29% [7]. The organ related mortality in perinatal asphyxia are due to pulmonary: (52—86%), Cardiac: (30—62.5%), CNS: (26—31.5%) and GIT (52%) [4-6]: Various clinical features related to cardiac impairment documented are respiratory distress, congestive cardiac failure, cardiogenic shock and systolic murmur[7]. However, in milder cases neonatal myocardial ischemia might be clinically occult. Some cardiac dysfunction is reported to be about 78% of full-term neonates with perinatal asphyxia. So clinical research during last couple of years has focused on two major topics: early detection of subclinical cardiac involvement in newborns with diagnosed perinatal asphyxia and early detection of the subset of neonates with high risk of poor clinical outcome/death [8]. Perinatal asphyxia is the most important cause of HIE, resulting in hypoxemia and hypercapnia. The major manifestations of asphyxia occur due to combined effect of hypoxia and ischemia of the brain and other vital organs. In term infants with acute encephalopathy due to perinatal asphyxia the cerebral hemodynamics is deranged in the first few days. After an episode of hypoxia and ischemia, anaerobic metabolism occurs and generate increased amount of lactate and inorganic phosphates. Excitatory and toxic amino acids, particularly glutamate, accumulate in the damage tissue. Subsequently activation of glutamate cell-surface receptors occurs which results in an influx of Na^+ and Ca^{2+} ions. Increased amounts of intracellular sodium and calcium may result in tissue swelling and cerebral edema [9]. Free fatty acids accumulate in the cytosol, due to increased membrane phospholipid turnover. Free fatty acids undergo peroxidation by oxygen-free radicals arising from the reductive process within mitochondria. Ca^{2+} ions accumulate within the cytosol as a result of increased plasma membrane influx via voltage-sensitive and agonist-operated calcium channels. Also there occurs decreased efflux of Ca^{2+} across the plasma membrane along with release from mitochondria and the endoplasmic reticulum [9]. Nitric oxide, a free-radical gas, is generated via Ca^{2+} activation in selected neurons. Generated nitric oxide then diffuses to adjacent cells that are susceptible to nitric oxide toxicity. The combined effects of cellular energy failure, acidosis, glutamate, and nitric oxide neurotoxicity, free-radical formation, Ca^{2+} accumulation, and lipid peroxidation serve to disrupt structural components of the cell with its ultimate death [9]. A better understanding of the cardiac status in patients with perinatal asphyxia done by assessing enzyme cardiac Troponin I level, detailed Echocardiographic and ECG information, would be useful to manage the asphyxiated newborn more precisely and improving their survival.

OBJECTIVES

General objective

- To observe the Significance of ECG changes in different stages of birth asphyxia and its correlation with Cardiac Troponin-I.

Specific objectives

- To correlate the degree of HIE with cardiac functional status.
- To find out the immediate outcome of the asphyxiated neonates with myocardial impairment.

METHODOLOGY AND MATERIALS

A total of 94 cases were selected during the study period. Out of them parents or legal guardians of 6 neonates refused to remain with the study procedure, 2 cases left with DORB, 11 cases were excluded according to exclusion criteria. Remaining 75 cases were included for study. These cases were found to have different stages of Hypoxic Ischemic Encephalopathy. Study results were analyzed to see the association of myocardial dysfunction with HIE, effect of myocardial dysfunction on mortality and prolonged hospital stay among these neonates. Statistical analyses of results were done by Statistical Package for Social Science (SPSS)-23 software package using a computer. X^2 test, Analysis of variance (ANOVA) and Pearson's correlation coefficient test were done for the purpose of analysis. Thorough clinical examination was done at admission and during hospital stay and followed up till discharge or death. Necessary laboratory tests were done to evaluate each patient including assessment of serum troponin- I ECG and Echocardiography. All investigations were done within 72 hours of age of the neonates. Cardiac impairments were evaluated by raised S. troponin I and echocardiographic information. Mortality and duration of hospital stay were recorded.

Inclusion Criteria

- Age: Less than 72 hours
- Gestational age: Term neonates
- H/O failure to take spontaneous respiration immediately after birth and/or
- Perinatal asphyxia evidenced by documented Apgar score (if available)

Exclusion Criteria

- Major congenital anomaly such as meningocele, meningoencephalocele,

congenital hydrocephalus and congenital brain parenchymal anomalies.

- Presence of any structural congenital heart disease
- Clinical features consistent with congenital infection.

RESULTS

Total 75 term neonates diagnosed as perinatal asphyxia with different grades of HIE were selected to evaluate the Significance of ECG changes in different stages of birth asphyxia and its correlation with Cardiac Troponin-I. Table-1 shows that the Demographic data according to various stages of HIE is presented in Table-1. No significant difference was seen among the neonates with HIE Stage-I, HIE stage-II and HIE stage-III groups with respect to parameters like birth weight, sex, gestational age, crown heel length (CHL), occipital frontal circumference (OFC), maternal age, and antenatal complications. Table-2 shows that among the total 75 cases, ECG changes were seen in 32(42.66%) patients, remaining 43 babies had no change in ECG. Maximum changes were noticed among the cases with HIE stage-III 21(28.00%), followed by HIE stage-II 10(13.33%) and Stage-I 1(1.33%). Most common type of ECG abnormality was Grade-II changes which was present in 16 patients. This was followed by Grade-III type of changes, found in 9 patients and Grade-I type seen in 7 patients. Table 3 & 5 shows that the Measurement of serum cardiac troponin I and determination of Myocardial performance index (Tei index), both are effective in assessment of myocardial dysfunction in asphyxiated neonates with HIE. Pearson's Correlation Coefficient (r) test was done to see whether the two methods correlate in diagnosing myocardial dysfunction.

Table-1: Demographic data according to HIE stages (n=75)

Demographic parameters		HIE stages			Chi Value	F-Value	P-value
		Stage-I	Stage-II	Stage-III			
Sex	Male	9	15	21	.93		.62
	Female	11	9	10			
Gestational age (weeks)		38.40±1.09	38.35± .67	38.15± 2.11		.172	.84
Maternal age	≤ 20yrs	12	14	21	.41		.81
	>20 yrs.	8	10	10			
Parity	Primi	11	9	11	1.77		.41
	Multi	9	15	20			
Birth Weight (Kg)		2.85± .17	2.89± .16	2.97± .17		2.50	.09
Length (cm)		47.98± .56	47.88± .52	47.81± .52		.469	.62
OFC (cm)		33.87± .35	33.96± .31	33.92±.29		.471	.62
Antenatal checkup	Regular	10	8	17	.44		.80
	Irregular	10	17	14			
Mode of delivery	Vaginal delivery	11	15	21	.53		.76
	Caesarian section	9	9	10			

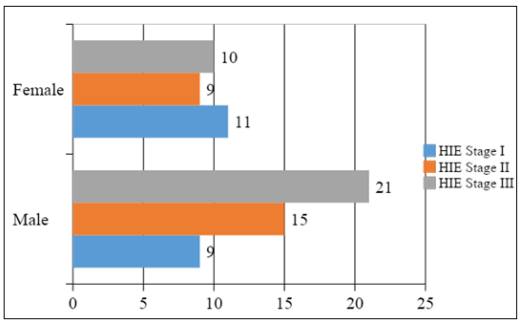


Fig-1: Sex distribution of study cases among different stages of HIE (n=75)

Table-2: ECG changes between different stages of HIE (n=75)

ECG Changes Grading	HIE Grading			Total
	Stage-I	Stage-II	Stage-III	
I	1	3	3	07
II	0	6	10	16
III	0	1	8	09
IV	0	0	0	00
Normal	19	14	10	43
Total	20	24	31	75

Grade-I ECG changes= With flat or inverted T waves on 1 or 2 leads except AVR.
Grade-II ECG changes= With flat or inverted T-waves in 3 or more leads except AVR
Grade-III ECG changes= With flat or inverted T-waves in 3 or more leads and either ST depression or elevation >2 mm in at least two chest leads or >1 mm in at least two standard leads, or a Q-wave abnormality of duration >0.02 s or amplitude >25% of R wave in one anterior or three related chest leads.
Grade- IV ECG changes= Presence of classical segmental infarction with abnormal Q-wave and markedly elevated ST segment or complete left bundle branch block.

Table-3: Comparison of cardiac troponin levels between different stages of HIE (n=75)

	Stage-I (m±SD) (n=20)	Stage-II (m±SD) (n=24)	Stage-III(m±SD) (n=31)	F-Value	P- Value
cTn I (ngm/ml)	.66±.21	.99±.52	1.47±.50	20.33	P = < .001 P1= .058 P2= .001 P3= < .001

Table-4: Comparison of systolic and diastolic myocardial dysfunctions among the different stages of HIE (n=75)

Criteria	Stage-I	Stage -II	Stage -III	F-Value	P-value
Left ventricular ejection fraction (LVEF)	64.4± 4.28	60.97± 5.42	54.05± 8.14	17.10	P= < .001 P1= .22 P2= .001 P3= < .001
Left ventricular fractional shortening (LVFS)	44.42± 8.13	40.67±11.03	31.48±9.97	11.81	P= < .001 P1= .46 P2= .004 P3= < .001
Left ventricular E/A Ratio	1.14±.15	1.07±.18	.88±.21	12.86	P= <.001 P1= .54 P2= .002 P3= < .001
TAPSE	1.02±.21	1.07±.30	1.36±.48	6.28	P= < .003 P1= .90 P2= .02 P3= < .01
Right ventricular E/A Ratio	.94±.05	.92±.04	.91±.03	1.97	P= .14 P1= .29 P2= .96 P3= .06

Table-5: Comparison of Myocardial Performance Index (Tei index) among different stages of HIE (n=75)

Criteria	Stage –I	Stage –II	Stage -III	F-Value	P-value
Left ventricular Tei Index	.39±.02	.41±.03	.47±.05	22.21	P= <.001 P1= .50 P2= < .001 P3= <.001
Right ventricular Tei Index	.29±.07	.33±.05	.42±.09	20.56	P= <.001 P1= .12 P2= <.001 P3=< .001

Table-6: Correlations of Cardiac Troponin I (cTn I) with LV and RV Tei Index among cases with different stages of HIE (n=75)

	Mean ± SD	Pearson's correlation coefficient (r)	P Value
cTn I	1.10±.56		
LV Tei Index	.43±.05	.30	.012
RV Tei Index	.36±.09	.33	.004

DISCUSSION

In this study, patients in different stages of HIE showed no significant difference regarding demographic parameters such as age, length, birth weight and Occipitofrontal Circumference (OFC). All the patients in each group were within 72 hours of age, mean birth weight in different group were (in HIE Stage-I 2.85±.17 kg, in HIE stage-II 2.89± .16 kg and in HIE stage-III 2.97± .17 kg), mean length were (in HIE Stage-I 47.98± .56 cm, in HIE stage-II 47.88± .52cm in HIE stage-III 47.81± .52 cm), and mean OFC (in HIE Stage-I 33.87± .35 cm, in HIE stage-II 33.96± .31cm, and in HIE stage-III 33.92± .29 cm). A study by Jain DD *et al* [10] had demographic parameters as follows: Mean weight (g) in HIE Stage-I, II and III were 2646 ± 292, 2872 ±192, and 2912 ±237. Mean Length (cm) in HIE Stage-I, II, and III were 45.7± 6.5, 47.2± 1.6, 46.9± 0.6. Mean OFC (cm) in HIE Stage-I, II and III were 34± 1.5, 33.7± 0.5 and 33.7± 0.4. Their study subject had demographic characteristics similar to the present study. In this study Cardiac troponin, I was found to be high in patients with perinatal asphyxia. Mean cTnI level (ngm/ml) in different stages of HIE were (.66±.21, .99±.52, and 1.47±.50 in HIE Stage-I, II, and III respectively). It is seen here that cTnI are rising significantly as the stages of HIE increases (P value < .001). Shastri *et al.,* [11] found in their study that cTnI concentrations correlate strongly with the clinical severity of HIE grades (0.04 lg/L in HIE-I, 0.12 lg/L in HIE-II and 0.67 lg/L in HIE-III). These findings are consistent with the current study. In the present study abnormal ECG changes seen in 32 (42.66%) neonates. Among them Grade-I ECG changes found in 7 (9.33%) patients, Grade-II changes seen in 16 (21.33%) patients, and Grade-III changes seen in 9 (12%) patients. In a study done by Rajakumar *et al.,* [12]. Grade I ECG changes were present in 6 (20%) cases, Grade II in 12 (40%) and Grade III in 4(13.3%) of asphyxiated neonates. Findings of this study were similar to the present study. Both LV and RV Tei index showed a positive correlation with cTn I (LV r value .30 and .RV r value .33 and P value .012 and .004 respectively). Khattab AAA *et al.,* [13]. Also found a positive correlation in this regard and having similar result with this study. In this study levels of cTni showed increasingly higher value with increasing severity of HIE, ECG abnormalities in the study also showed changes in the same manner [14].

LIMITATIONS OF THE STUDY

This was a descriptive study in a single community with comparatively small number of sample size. So, the study result may not reflect the exact scenarios of the whole country.

CONCLUSION

Perinatal asphyxia affects multiple organ system including myocardium which is one of the major contributing factors for neonatal morbidity and mortality. The more severe the neurological involvement (as evident by increasing stages of HIE) the more probability of myocardial impairment. The reduced myocardial performance following perinatal asphyxia can contribute to increased end-organ damage and thus responsible for increased mortality and morbidity. A better understanding of the cardiac status in patients with perinatal asphyxia done by assessing enzyme cardiac Troponin I level, and detailed Echocardiographic information, would be useful to manage the asphyxiated newborn more precisely and improving their survival. Cardiac troponins are very sensitive markers for the detection of myocardial damage. Cardiac troponin-I level increases significantly in cases with cardiac dysfunction due to perinatal asphyxia. Electrocardiography also shows significant abnormality in moderate and severely asphyxiated neonates. Therefore ECG may be used as an early noninvasive predictor of myocardial impairment for asphyxia neonates.

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