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Study of electrocardiographic changes in Asphyxia Neonatorum and analysis of morbidity and mortality pattern following myocardial ischemia

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Original Research Article

Abstract: ECG is a simple, cheap, easily available investigative tool and yet informative regarding the state of neonatal heart and effects of anoxia on it. Therefore this prospective study was conducted to evaluate the Electrocardiographic changes in Asphyxia Neonatorum and analyse the morbidity and mortality pattern following myocardial ischemia. **Material and Methods:** Present study was single-center, prospective, observational study, conducted in neonates in the age group of 1-28 days, either gender, term neonates, weighing more than 2 kg, predicted to be asphyxiated by Apgar Scoring as Mild, Moderate and Severe asphyxia. Study conducted in 25 neonates with birth asphyxia and 25 normal neonates who were taken as control. **Results:** All of the 25 cases and 25 controls displayed regular sinus rhythm. In asphyxiated neonates the heart rate was higher on day-1 than on day-28. In controls the heart rate increased with age. In present study, P wave amplitude ranged between 0.5 to 2.0 mm and was greater in asphyxiated babies (P value: less than 0.05). This increased with age in both the groups. Q wave more than 2 mm was observed in asphyxiated neonates in I, III and AVF. These disappeared in majority by 28th day but persisted in Four cases in lead III and in 5 cases AVF at one month. RV1 + SV6 was greater in asphyxiated neonates. Repeat ECG's on follow up revealed reduction in amplitude in both the groups. T-'wave flattening was the commonest observation. Inversion of T' wave was also commonly observed with greatest incidence in inferior limb and mid-precordial leads. The changes reverted to normal in majority by 28th day. PR interval was more in asphyxiated babies then in controls, it decreases with age in both the groups. **Conclusion:** Severely asphyxiated babies have changes persistent to 28th day and they were who had CCF.

Keywords: asphyxia, ECG changes, Asphyxia Neonatorum, myocardial ischemia

Introduction

The belief that myocardial ischemia following birth asphyxia can be accurately diagnosed clinically in majority of instances, where perinatal stress is followed by respiratory distress, cardiogenic shock congestive heart failure, murmur of Tricuspid or mitral regurgitation in varying combinations with abnormal electrocardiograms was further strengthened by good degree of correlation with pathological studies of myocardial muscle enzyme studies and myocardial perfusion scans.[1]

Anoxia affects the cardiac function and hypotension, so caused may reduce the cardiac output leading to features of myocardial infarction due to inadequate coronary perfusion and arrythmia in some.[2] Electrocardiographic abnormalities in the form of T wave changes have been linked with Asphyxia.[3]

ECG is a simple, cheap, easily available investigative tool and yet informative regarding the state of neonatal heart and effects of anoxia on it. Therefore this prospective study was conducted to evaluate the Electrocardiographic changes in Asphyxia Neonatorum and analyse the morbidity and mortality pattern following myocardial ischemia.

Material And Methods

Present study was single-center, prospective, observational study, conducted in department of paediatrics, at Government Medical College & Hospital, Nagpur, India. Study duration was of 18 months (Feb 1992 to July 1993). Study approval was obtained from institutional ethical committee.

Inclusion criteria

- Neonates in the age group of 1-28 days, either gender, term neonates, weighing more than 2 kg, predicted to be asphyxiated by Apgar Scoring as Mild, Moderate and Severe asphyxia, parents willing to participate in present study

Exclusion criteria

- Neonates not diagnosed at our hospital

- Neonates not predictated to be asphyxiated by Apgar scoring.
- Neonates who received sedation.

Study was explained to parents in local language & written consent was taken for participation & study. Total 50 term neonates were studied. In all the patients detailed Antenatal and Natal history was taken and patients were thoroughly examined. Detailed physical and neurological examination was done 25 neonates with birth asphyxia and 25 normal neonates who were taken as control. Neonates were considered asphyxiated if the Apgar score was seven or less at one and five minutes of birth. The degree of asphyxia was graded as mild, moderate and severe if the Apgar Score was 5-7, 3-4 and 0-2 respectively. Of 25 asphyxiated neonates 4 had mild, 12 had moderate and 9 had severe degree of Asphyxia. The remaining 25 neonates served as healthy controls.

The standard 12 lead ECG was recorded by portable machine at birth and repeated on 28th day. The instrument was standardised to give a 10mm deflection with the introduction of 1 millivolt into the circuit. The standard limb leads, augmented unipolar limb leads and the precordeal leads from V1 to V6 were recorded. Paper speed of 25 mm per second was used. The parameters studied were heart rate, rhythm, P, Q, R, S, T waves, QRS duration, R/S ratio's & ST segment. The amplitude and duration of various waves and intervals were measured with a magnifying glass.

Data was collected and compiled using Microsoft Excel, analysed using SPSS 23.0 version. Frequency, percentage, means and standard deviations (SD) was calculated for the continuous variables, while ratios and proportions were calculated for the categorical variables. Difference of proportions between qualitative variables were tested using chi- square test or Fisher exact test as applicable. P value less than 0.5 was considered as statistically significant.

Results

The present study comprises of fifty neonates, serial electrocardiograms were recorded in the 25 neonates with Birth Asphyxia and in 25 normal neonates who were taken as controls. Both the sexes were equally affected.

Table 1: Gender

Gender	Study group		Control group	
	No. of neonates	Percentage	No. of neonates	Percentage
Male	11		13	
Female	14		12	

All of the 25 cases and 25 controls displayed regular sinus rhythm. None of the electrocardiogram revealed irregularity in the rhythm. In present study, in asphyxiated neonates the heart rate was higher on day-1 than on day-28. In controls the heart rate increased with age.

Table 2: Showing mean heart rate in cases & Controls

Subjects	Day-1	Day-28
Cases	133.52	129.00
Controls	145.84	148.88

In present study, P wave amplitude ranged between 0.5 to 2.0 mm and was greater in asphyxiated babies (P value: less than 0.05). This increased with age in both the groups.

Table 3: Mean P wave Amplitude in Lead II (mm)

Subjects	Day-1	Day-28
Cases	1.1	1.32
Controls	0.88	1.06

Q wave more than 2 mm was observed in asphyxiated neonates in I, III and AVF. These disappeared in majority by 28th day but persisted in Four cases in lead III and in 5 cases AVF at one month.

Table 4: Significant Q waves. (More than 2 mm)

Leads	Day-1	Day-28
Lead III	11 (44%)	4 (16%)
AVF	9 (36%)	5 (20%)

P' value - P less than 0.05

RV1 + SV6 was greater in asphyxiated neonates. Repeat ECG's on follow up revealed reduction in amplitude in both the groups.

Table 5: RV1 + SV6 in patients & controls

Cases	**Day-1**	**Day-28**
Patients	15.32	14.42
Controls	12.1	11.28

P' value - P less than 0.05

T-'wave flattening was the commonest observation. Inversion of T' wave was also commonly observed with greatest incidence in inferior limb and mid-precordial leads. The changes reverted to normal in majority by 28th day.

Table 6: T wave characteristics

	I	**II**	**III**	**AVF**	**AVL**	**AVF**	**V1**	**V2**	**V3**	**V4**	**V5**	**V6**
Day 1												
Upward	17	19	6	1	11	-	13	3	4	7	9	10
Downward	2	1	7	18	2	7	17	19	16	15	14	12
Biphasic	-	-	-	-	-	-	-	-	-	-	-	-
Flat	5	4	11	7	9	6	2	3	3	3	2	5
Day 28												
Upward	10	12	2	-	5	7	2	5	5	4	4	7
Downward	1	-	4	12	3	1	10	8	8	10	9	7
Biphasic	-	-	-	-	-	-	-	-	-	-	-	-
Flat	2	2	6	2	3	6	-	-	1	-	-	-

PR interval was more in asphyxiated babies then in controls, it decreases with age in both the groups.

Table 7: Mean PR interval (in seconds)

Cases	**Day-1**	**Day-28**
Patients	0.092	0.077
Controls	0.065	0.060

P'value : P less than 0.01.

ST elevation wa observed in II, III, AVF & chest leads in asphyxiated neonates.ST depression was seen more commonly in V1 to V6 leads. St segment became isoelectric within 28 days in limb leads & chest leads in majoriy of cases.

Table 8: ST segment characteristics

	I	**II**	**III**	**AVF**	**AVL**	**AVF**	**V1**	**V2**	**V3**	**V4**	**V5**	**V6**
Day 1												
Upward	-	-	1	-	-		1	2	-	-	3	-
Downward	-	-	-	-	-	-	4	6	-	-	-	1
Isoelectric	-	-	-	-	4	2	-	-	-	2	2	-
Day 28												
Upward	-	-	-	-	-	-	-	1	1	-	-	-
Downward	-	-	-	1	-	-	-	-	-	2	-	2
Isoelectric	-	-	-	1	1	3	-	-	-	-	-	-

QRS duration was more in asphyxiated babies then in controls, it decreases with age in both the groups.

Table 9: QRS duration (in seconds)

Cases	**Day-1**	**Day-28**
Patients	0.06	0.047
Controls	0.045	0.046

P'value : P less than 0.01

Mean QTc was more in both the groups on day 1.

Table 10: Mean QTc (in seconds)

Cases	Day-1	Day-28
Patients	0.42	0.39
Controls	0.39	0.37

P'value : P less than 0.01

Discussion

ECG recording is a good parameter for diagnosis of ischemic damage of heart and it has a fairly good relation with myocardial histology and thallium imaging. Among the various methods employed for the recognition of heart ailments, the electrocardiography still remains an empirically derived tool in the diagnosis of congenital as well as acquired heart disease. Despite the many advances in cardiac electrophysiology, there is still a gap between it and clinical application of electrocardiology.

The present study included fifty neonates after fulfilling the criteria for selection, serial electrocardiograms were recorded in the 25 neonates with Birth Asphyxia and in 25 normal neonates who were taken as controls.

Criteria for ECG diagnosis of ischemic damage have been laid down[3] taking following into consideration eg. Flat or inverted T waves, ST segment depression, abnormal Q waves.

In asphyxiated neonates, the heart rate was higher on day-1 than on day-28. In controls the heart rate increased with age. The mean heart rate was high on day-1. Decrease in the heart rate with increasing age in asphyxiated babies is well documented by Daga S.R.*et al.*,[4]

In our study heart rate of babies ranges 120 - 133.52. S.D. 29.84 on day 1, 19.90 on day between 28th . This difference of cases and control is not significant (P value greater than 0.05). At birth the characteristic of babies as per weight, anthropometric features were similar in both groups. Out of 25 in each group male 13, female 12 in control, male 11, female 14 in cases, although in this study the male and female were not equally enrolled, it is unlikely that this will become confirmed up and influenced the study as there is no specific evidence in literature that at birth there exist significant difference in E.C.G. in male and female babies.

Status of all these babies were evaluated by using APGAR score, it has good predictive value for asphyxia and this currently used in pediatric practice widely. Assessment of APGAR score reveals that these babies, they did not have same degree of asphyxia, severe 2. moderate 12, mild 4. These number is unlike to influence ECG changes depending upon asphyxia, however there pattern persists reflecting ECG changes on 28th day.

P wave amplitude difference in case and control mean, cases 1.1 on day 1, 0.32 on 28th day, in control 8.88 on day 1 and 1.06 on day 28th. Standard deviation 0.54 and 0.46 is significant statistically as it is less than 0.05. On 28th day it was highly significant. Changes induced because of hypoxia in the heart are not uniformed, individual system either conduction or activity of ventricl (Machanical performance and electrical potential) might become susceptible reflecting appropriate changes in one of these component not necessarily uniform. Similar results are quoted by Daga S.R.*et al.*,[4]

PR interval reflects impulse conduction from atrium to excitation of ventricles in terms of time shows that interval is longer in cases and shorter in controls. although heart rate shows proportionate changes in normal circumstances like shorter PR interval more is the heart rate, longer PR interval less is the heart rate, but in this study similar relationship was not shown even though PR interval was significantly different in cases and control. Heart rate was not significant.

The maximum PR interval was 0.24 sec and the minimum 0.6 sec. Gidvani C.H. & Raju U.[5] has made such correlation with asphyxia.

QRS duration, in cases mean 0.06 on day 1 and on 28th day 0.049, controls 0.045 on day 1 and 0.046 on 28th day. QRS duration has prolonged in cases which reflects poor ability of myocardium and conduction system to induce normal excitation, this difference is statistically significant (P value less than 0.01).

Corrected QT interval mean, in cases 0.42 on day 1 and 0.39 on 28th day in control 0.39 on day 1 and 0.37 on 28th day. This difference was significant at birth and 28th day also. S.T. segment changes were not consistent in all cases in few they show normal in 9 babies who were severly asphyxiated shows saging of ST segment like strain pattern.

ST segment elevation in II, III and AVF was observed in four severely asphyxiated neonates. ST depression was seen more commonly in V3, V4, V5 V6 Widespread ST depression, flattening and inversion of T waves suggestive of inferior wall and

anteroseptal ischemia has also been observed by Gidvani C.H. & Raju U.[5] they found ST depression more commonly in V_1, V_1 leads. Daga S.R.*et al.*,[4] also quoted similar findings. In the remaining cases the clinical improvement preceded the regression in ECG changes indicating the great ability of neonatal heart to withstand hypoxic insult.

RV1 + SV6 which in normal circumstances reflects electrical excitation of right ventricle. Mean cases. 15.32 and 14.42, controls 12.1 and 11.28, this difference was statistically significant P value less than 0.05, at the same time RV and SV, did not appear significantly 1 affected because of hypoxia. A striking change in asphyxiated babies and significant waves in lead III and AVF which reflects relationship with significant changes in right ventricle as compared to left.

Flattening and inversion of T waves suggestive of inferior wall and anteroseptal ischemia. Inversion of T waves was commonly observed with greatest incidence in inferior leads and midprecordial leads. These changes reverted to normal in few cases Flattening and inversion of T waves suggestive of inferior wall and anteroseptal ischemia. Inversion of T waves was commonly observed with greatest incidence in inferior leads and mid-precordial leads.

These changes reverted to normal in few cases and persisted till one month in severely asphyxiated neonates. Similar observations are quoted by Gidvani C.H. & Raju U.[5] RS Ratio: The present study revealed that the RS Ratio on day 1 was more than the RS Ratio on day 28 in both cases and control and that RS ratio fell from V_1 to V6.

Alimurung M.M. *et al.*,[6] attributed this reversal of adult type of R/S ratio in the neonate to difference in relative size and thickness between the two ventricles in infancy as compared to adult age. Burnard E.D.[7] also quoted similar finding he found (Rt) as well as (Lt) ventricular dilatation similar findings were reported by Desa D.J[8].

Overall ECG of asphyxiated babies is different from that of normal baby at birth, most of these changes like persistent of waves, persistent of ST changes and increase in P wave amplitude did not disappear even on 28th day in severely asphyxiated babies. These electrical changes did not merely manifest in ECG but correlate with biological disturbances in terms of function of heart. Four asphyxiated babies had evidence of CCF. which was different from cases who did not have CCF.

Conclusion

It appears that changes in the heart induced by asphyxia is not necessarily uniformed in mechanical function of heart and however severity of asphyxia is one of the important determinant of persistent of ECG changes and functioning of the heart. Severely asphyxiated babies have changes persistent to 28th day and they were who had CCF. All asphyxiated babies at severe asphyxia did not have similar event of CCF there should be some unknown reasons, which act together and produce derangement of functioning of the heart. The changes were more significant in right ventricle as compared to the left.

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