SERUM ELECTROLYTE AND CALCIUM ABNORMALITIES IN NEONATES WITH BIRTH ASPHYXIA

Abstract:

Introduction: Birth asphyxia and Hypoxic–ischemic encephalopathy (HIE) are major causes of neonatal mortality and morbidity. Serum sodium, potassium and calcium level abnormalities may occur in neonates with birth asphyxia and their early detection and prompt treatment will improve outcome of these neonates. *Aim*: To study serum electrolyte and calcium levels and their correlation with severity of birth asphyxia and HIE. *Method*: A prospective cross-sectional study was conducted in full term neonates diagnosed with birth asphyxia and their serum sodium, potassium and calcium estimation was done at birth to 12 hours of birth and repeated at 24 to 48 hours of birth. Serum electrolyte and calcium level abnormalities and short-term outcome of these neonates was studied. *Results*: It was observed that at Apgar score 1 and 5 minutes, with increase in severity of birth asphyxia serum sodium and calcium levels decreased while potassium levels increased. Significant positive correlation observed between serum sodium levels and Apgar score at 1 and 5 minutes. Serum calcium levels showed significant positive correlation with 5 minutes Apgar score. Serum potassium levels at < 12 hours showed significant negative correlation with 5 minutes Apgar score. *Conclusion*: With increased severity of HIE and Birth asphyxia serum sodium levels decreased and serum potassium levels increased. Serum calcium levels decreased with severity of birth asphyxia but did not decrease with increase in severity of HIE.

Keywords: Birth asphyxia, Hypoxic ischemic encephalopathy, serum sodium, serum potassium, serum calcium.

Introduction:

Birth asphyxia continues to be a major cause of mortality and morbidity in neonates despite advances in neonatal medicine. Globally, birth asphyxia accounts for 17% of neonatal deaths and severe neurological sequelae occur in 25% of surviving infants[1]. National neonatal perinatal database shows that in India birth asphyxia contributes to almost 23% of neonatal mortality[2]. Though multiorgan involvement, including kidneys, liver and lungs, is seen in neonates with birth asphyxia, involvement of the central nervous system is more detrimental.

The incidence of birth asphyxia ranges from 0.5–2% of live births. It is often associated with multiple pathophysiological consequences, which lead to multiorgan dysfunction. Decreased perfusion leads to devastatiang complications both immediate and long-term[2].

Hypoxic–ischemic encephalopathy (HIE) as one of these complications is among the leading causes of neonatal brain injury and neonatal morbidity, as well as mortality. HIE causes the augmented secretion of anti-diuretic hormone which leads to increased retention of water and dilutional hyponatremia. Another possible reason for hyponatremia in HIE could be

disproportionate sodium reabsorption in collecting tubules resulting in elevated sodium excretion. Hyperkalemia is a common finding in HIE and occurs because of increased acidosis which leads to the shift of intracellular potassium to the extracellular environment. In addition, acute kidney injury which is a frequent complication due to HIE can result in hyperkalemia. Immediately after birth, neonatal calcium level starts to fall and reaches the nadir at 24-28 hours. In response to this, parathyroid hormone (PTH) level rises and maintains calcium hemostasis. It should be noted that HIE decreases the effect of PTH which can be a potential cause of hypocalcemia[3].

The objectives of the current study were to correlate the abnormalities of serum sodium, potassium and calcium level with severity of birth asphyxia and HIE staging, to study the immediate short term outcome of neonates with birth asphyxia and correlate it with serum electrolyte and calcium levels.

Material and Methods:

This study was a prospective cross-sectional study that was conducted in department of paediatrics, AVBRH, Sawangi (Meghe), Wardha from period of August 2018 to July 2020. A total of 85 cases with history of birth asphyxia were included in the study.

Full term neonates with birth asphyxia admitted in the NICU of AVBRH within 12 hours of birth satisfying the following criteria[3]

For inborn babies:

Birth asphyxia: Apgar score at 1 minute < 7 , Moderate birth asphyxia: Apgar score between 4 to 6 at 1minute of age, Severe birth asphyxia: Apgar score ≤ 3at 1minute of age.

For outborn babies: Moderate birth asphyxia: Gasping breathing at 1-minute of age, Severe birth asphyxia: No breathing at 1-minute of age. After inclusion of the neonate with birth asphyxia in this study a detailed history with sequence of were noted.

Neonates with major lethal congenital anomalies, suspected metabolic diseases and born to mothers on antiepileptic drugs, antihypertensive drugs or treated with magnesium sulphate, mothers with diabetes mellitus and abnormal serum electrolyte values were excluded. A written informed consent was obtained from parents of these neonates. After inclusion of the neonate with birth asphyxia in this study a detailed maternal history, antenatal history, detailed birth history with sequence of events, resuscitation details, Apgar score at 1 and 5 min, gestational age assessment based on modified Ballard score and management at birth were noted. A thorough general examination of the neonates with pulse, respiratory rate, CRT (capillary refill time), temperature, screening for clinical signs of sepsis, screening for congenital anomalies was done followed by detailed systemic examination. After obtaining informed consent from parents of these neonates Serum sodium, potassium and calcium estimation was done at birth to 12 hours of birth and repeated at 24 to 48 hours of birth. Ion-selective electrode method was used to analyze the serum samples for electrolytes and calcium by automated machine. In the proforma all investigations along with serum sodium, potassium, calcium, serum creatinine, blood urea, blood sugar, ABG, NUSG, EEG etc noted along with the treatment given. Immediate short term outcome of the neonate at discharge with neurological evaluation was done. This data was entered in the Microsoft excel sheets and then statistically analysed. Descriptive and inferential statistical analysis was done using Stata software (Stata 10, Stata corporation Texas, USA). Mean, median and standard deviation were used to analyse quantitative data. Qualitative data was summarized using percentage and proportions differences in proportion were compared by chi square test and Fischer's exact text. Differences between means were compared by unpaired student's 't' test. ANOVA test used for comparison of mean values of different electrolytes with different severity of birth asphyxia. Correlation coefficient was calculated by using Pearson test.

Median and quartiles of serum sodium, potassium and calcium with respect to Apgar scores was shown by using box plot. p value less than 0.05 is considered as level of significance

Results:

In this study, 53 (62.35%) were males and 32 (37.65%) were females. 68(80%) neonates were inborn and 17(20%) were outborn. 42 (49.41%) neonates were delivered through normal vaginal route, 42 (49.41%) were via LSCS and 1 (1.18%) was delivered through forceps (Table no.1).

Out of 85 neonates with birth asphyxia, at 1 minute of life, 8(9.41%) were having Apgar score <4 and 77 (90.59%) were having Apgar score 4-6. Out of 68 inborn neonates 7 (10.29%) were having Apgar score <4, 61 (89.70%) were having 4-6 at 1 minute of life.Out of 17 outborn neonates, 1 (5.88%) was having Apgar score <4,16 (94.12%) were having Apgar score 4-6 at 1 minute of life(Table no.2).

Out of 8 neonates with Apgar score < 4 at one minute 7 (87.5%) were inborn and 1 (12.5%) was outborn. Out of 77 neonates with Apgar score 4-6 at one minute 61 (79.22%) were inborn and 16 (20.77%) were outborn.

Out of 85 neonates with birth asphyxia, 5 neonates had Apgar score <4 at 5 minutes out of which 4(80%) were inborn, 1 (20%) were outborn. 7 neonates had Apgar score 4-6, out of which 6(85.71%) were inborn, 11 (14.28%) were outborn. 73 neonates had Apgar score ≥7, out of which 58 (79.45%) were inborn, 15 (20.54%) were outborn (Table no.3).

At Apgar score 1 minute, on comparing mean sodium levels between Apgar score <4 and 4-6 were statistically significant both at <12, 24-48 hours with p values<0.017 and <0.005 respectively. Potassium and calcium levels were statistically significant at<12 hours with p values<0.021, 0.000 respectively(Table no.4) . At Apgar score 5minute, on comparing mean potassium levels between Apgar scores they were statistically significant at 24-48 hours with p value<0.001. sodium and potassium levels were statistically not significant(Table no.5). Correlation coefficient calculated by using Pearson test. Median and quartiles of serum electrolytes with respect to Apgar scores was shown by Box plot. Positive correlation was present between serum sodium levels and Apgar score at 1 and 5 minutes which was statistically significant.With increase in severity of asphyxia serum sodium levels decreased both at <12 and 24-48 hours(Fig.1).Between serum potassium levels at <12 hours and Apgar score 5 minutes significant negative correlation was noted.With increase in severity of asphyxia serum potassium levels decreased both at <12 and 24-48 hours (Fig.3&4). Significant positive correlation was present between serum calcium levels at<12 hours and Apgar score 1 and 5min. And the calcium levels at 24-48 hours have significant correlation with Apgar score 5 min. with increase in severity of asphyxia serum calcium levels decreased both at <12 and 24-48 hours.

When the means of sodium, potassium and calcium levels compared with stages of HIE, sodium levels were statistically significant at<12 hours with p value<0.032 and potassium levels were statistically significant at<12 and 24-48 hours with p values<0.037, <0.003 respectively(Table no.6). As the HIE stage increase from 1 to 3, levels of serum sodium levels decreased(Fig.2) which was statistically significant and the serum calcium levels also decreased which was statistically not significant. whereas potassium levels increased both at<12 and 24-48 hours(Fig.5) which was statistically significant.

There was statistically significant difference in potassium (p=0.000) and calcium levels (p=0.025) at 24-48 hours of life of neonates who got discharged, died and went discharge against medical advice.

TABLES

Table no.1: Baseline Characteristics of neonates.

Characteristics of cases	Number of cases	Percentage
SEX Male Female	 53 32	 62.35 37.65
MODE OF DELIVERY NVD LSCS ASSISTED	 42 42 1	 49.41 49.41 1.18
PLACE OF DELIVERY Inborn Outborn	 68 17	 80 20
APGAR at 1min. <4 4-6	 8 77	 9.41 90.59
APGAR at 5min. <4 4-6 ≥7	 5 7 73	 5.88 8.23 85.88

Table no.2: Apgar score at 1 minute in neonates with birth asphyxia

Apgar at 1 min.	**INBORN (n=68) (%)**	**OUTBORN (n=17) (%)**	**TOTAL (%)**
<4	7 (10.29)	1 (5.88)	8(9.41)
4-6	61 (89.7)	16 (94.11)	77(90.59)
TOTAL	68 (80)	17 (20)	85(100)

Table 3: Apgar score at 5 minute in neonates with birth asphyxia.

Apgar @ 5 min.	**INBORN (%)**	**OUTBORN (%)**	**TOTAL (%)**
<4	4 (5.88)	1 (5.88)	5 (5.88)
4-6	6 (8.82)	1 (5.88)	7(8.23)
≥7	58 (85.2)	15 (88.2)	73(85.88)
TOTAL (%)	68(80)	17(20)	85(100)

Table no.4: correlation of serum electrolytes at <12 hours and 24-48 hours with APGAR score at 1 min.

APGAR @1min (n)	Na (MEAN ± S.D)		K (MEAN ± S.D)		Ca (MEAN ± S.D)	
	<12 hours	24-48 hours	<12 hours	24-48 hours	<12 hours	24-48 hours
<4 (8)	134.5±6.09	132.2±8.01	6.11±0.30	6.11±0.49	7.4±0.41	8.1±0.99
4-6 (77)	140.2±6.37	140±7.36	5.47±0.75	5.53±1.19	8.6±0.89	8.6±0.88
p value	0.017	0.005	0.021	0.180	0.000	0.160

Table no.5: correlation of serum electrolytes at <12 hours and 24-48 hours with APGAR score at 5 min.

APGAR @5min (n)	Na (MEAN ± S.D)		K (MEAN ± S.D)		Ca (MEAN ± S.D)	
	<12 hours	24-48 hours	<12 hours	24-48 hours	<12 hours	24-48 hours
<4(5)	131.2±5.35	129±8.60	6.10±0.40	6.4±0.29	7.2±0.27	7.4±0.46
4-6 (7)	138±4.43	139.4±5.94	5.7±1.00	5.5±0.41	8.1±0.80	8.8±0.64
≥7(73)	140.4±6.38	140±7.39	5.4±0.73	5.5±1.21	8.6±0.88	8.6±0.89
p value	0.528	0.721	0.194	0.001	0.067	0.220

Table no.6: correlation of serum electrolytes at <12 hours and 24-48 hours with HIE stage:

HIE stage (n)	Na (MEAN ± S.D)		K (MEAN ± S.D)		Ca (MEAN ± S.D)	
	<12 hours	24-48 hours	<12 hours	24-48 hours	<12 hours	24-48 hours
1 (51)	141.2±5.13	139.9±7.25	5.4±0.61	5.5±1.36	8.6±0.78	8.7±0.83
2 (23)	138.1±7.91	138.8±9.16	5.4±0.96	5.6±0.71	8.2±1.01	8.4±0.95
3 (11)	135.9±7.47	137±6.67	5.8±0.82	5.7±0.87	8.1±1.17	8.2±1.02
p value	0.032	0.341	0.037	0.003	0.137	0.593

Note: Serum sodium and potassium values are in mEq/L and serum calcium values are in mg/dL.

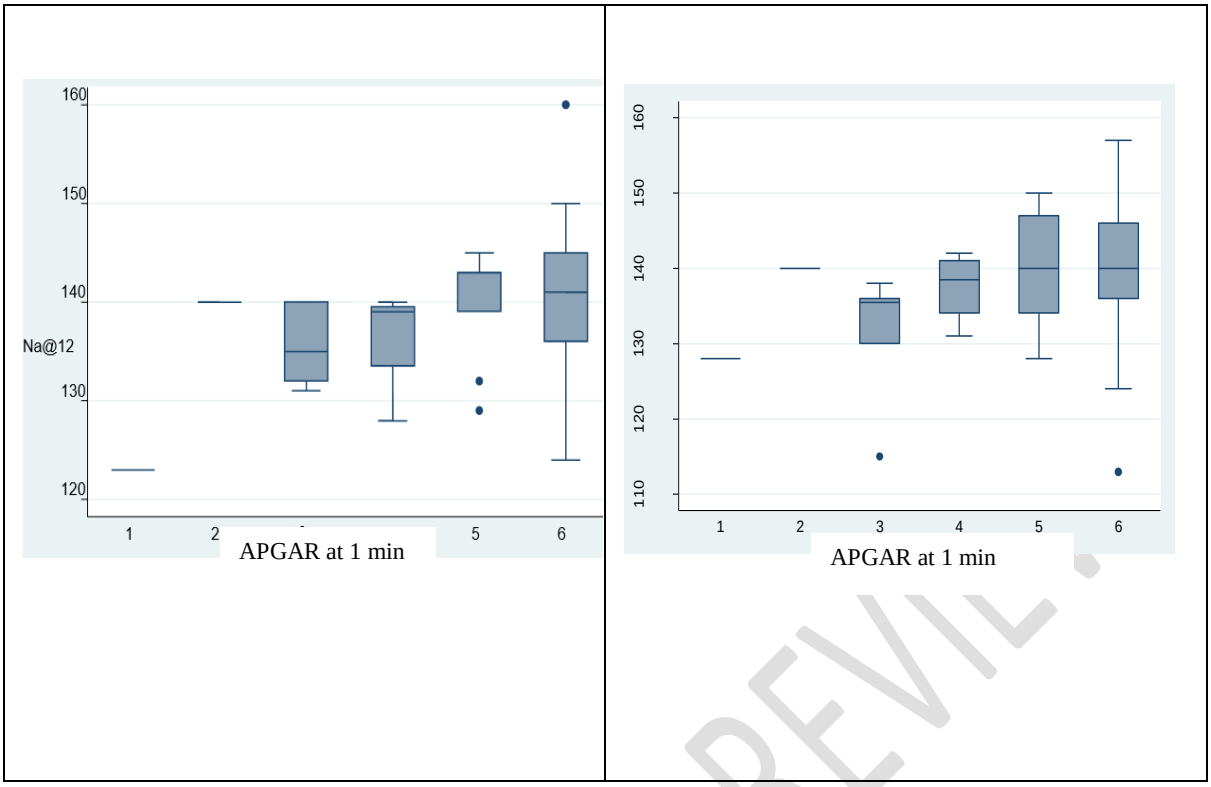

Fig.1Showing median and quartiles of serum sodium at 1 min Apgar.

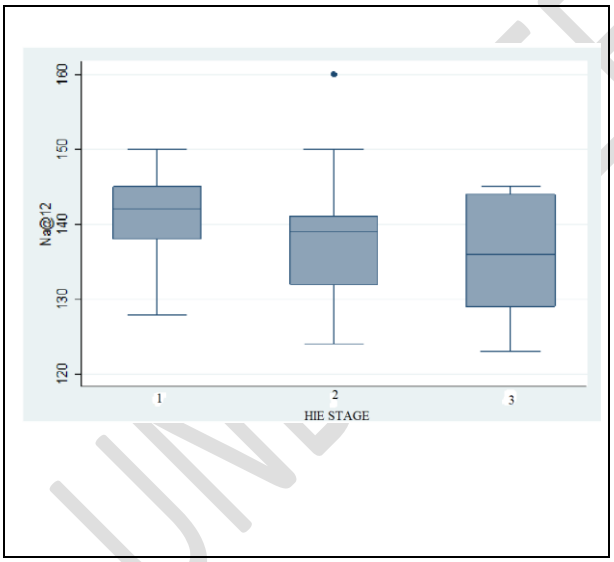

Fig. 2 Showing median and quartiles of serum sodium at <12 hours at different stages of HIE.

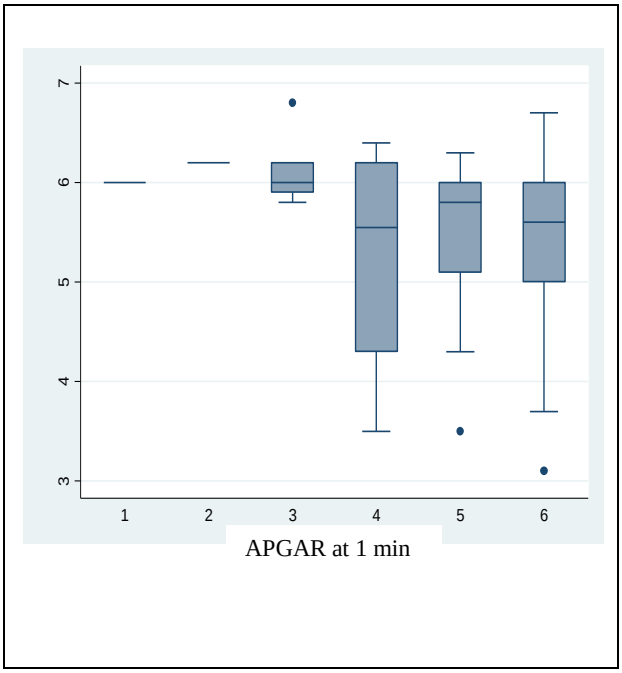

Fig.3 Showing median and quartiles of serum potassium levels at <12 hours 1min Apgar.

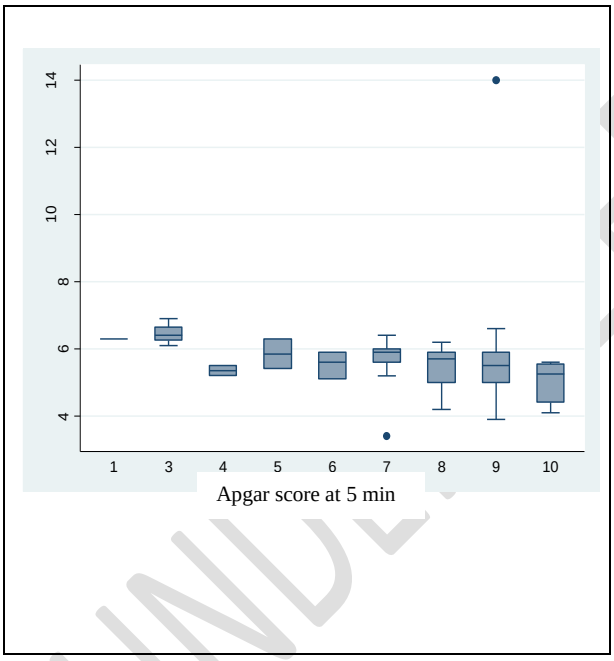

Fig.4 Showing median and quartiles of serum potassium at 5 min Apgar.

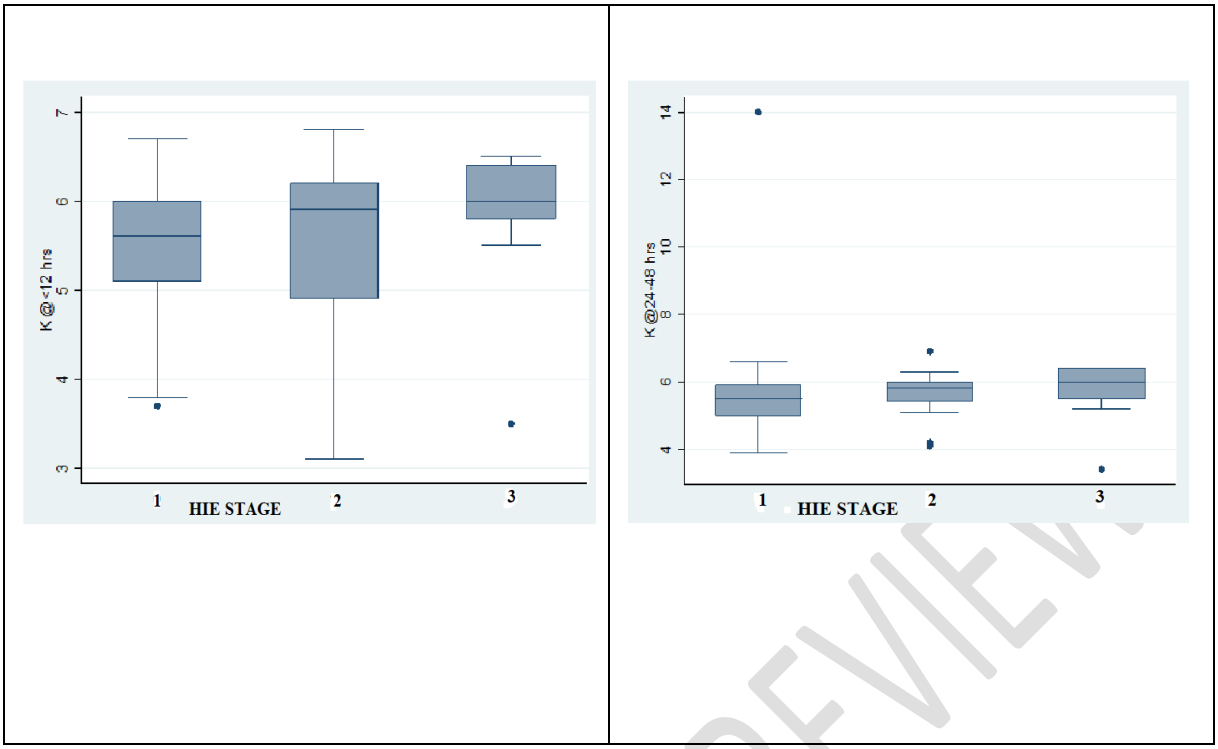

Fig.5 Showing median and quartiles of serum potassium at different stages of HIE

Discussion:

In the current study, out of all 85 cases with birth asphyxia, neonates having severe birth asphyxia showed less sodium levels when compared with moderate birth asphyxia which was statistically significant. Similar results were seen in Kumar SD et al[4]. where 1min. Apgar score was shown to have a positive significant correlation with sodium. In Islam A et al[5], Narbir Yadav et al[6]. when compared with the controls neonates with asphyxia were found to have less serum sodium and the sodium levels were positively correlated with Apgar score. Where as in Muduli Jk et al[7]. serum sodium levels were less in controls than cases which were similar and hence statistically not significant.

In this study five-min Apgar score showed significant positive correlation with sodium levels at <12 and 24-48 hours. This finding was similar to studies conducted by Allam Bhat J et al[8], Kumar SD et al[4], Thakur et al[9], Najaf Masood et al[10], Pallab Basu et al[11]. Where as in Nilesh V. Ahire et al[12]. serum sodium(hyponatremia) had no significant linear correlation with severity of asphyxia.

In our study revealed that as the severity of HIE increased, sodium levels decreased and sodium levels comparison between various stages of HIE was significant at <12 hours.Other authors[8,9,13,14] also found similar results with the present study.

Similar to current study, In Islam A et al[5]. and Kumar SD et al[4]. in their study found that severely asphyxiated neonates had higher serum potassium levels when compared with mild/moderate cases and controls, and negative correlation was observed with Apgar score at one minute. Where as in Muduli Jk et al[7]. serum potassium levels in controls and cases were almost similar and statistically not significant.

Similar to current study, other authors[8,4,9,11] in their studies found significant negative correlation of serum potassium levels with 5 minutes Apgar score.

Similar to our study, in Allam Bhat J et al[8]., Thakur et al[9]. and Shah et al[13]. as the severity of HIE increased, potassium levels increased and potassium levels comparison between various

stages of HIE was statistically significant. Where as in Jayaprakash K et al[14]. potassium levels were decrased in HIE-3 stage which was statistically not significant.
Similar to calcium levels at 24-48 hours in the current study, Islam A et al[5]. and Kumar SD et al[4]. in their study found that serum calcium levels in severely asphyxiated neonates were lower when compared to mild/moderate cases and controls which was not showing significant correlation with Apgar score at one minute.

Similar to current study, Najaf Masood et al[10]. and Pallab Basu et al[11] in their studies described that serum calcium levels in cases were significantly lower than in controls and hypocalcemia showed significant linear correlation with Apgar score at 5 minutes. Contradicting to this study, In studies conducted by Allam Bhat J et al[8]. and Thakur et al[9]. calcium showed no significant correlation with Apgar score at 5min.
Similar to current study, in the study conducted by Allam Bhat J et al[8]. as the severity of HIE increased, calcium levels decreased and the comparison of serum calcium levels between various stages of HIE showed no statistical significance. Contradicting to this study, in the studies conducted by Thakur et al[9]., Shah et al. and Jayaprakash K et al[14]. Calcium levels showed significant difference when compared between various stages of HIE.

In the current study, out of all 85(82.3) cases with birth asphyxia, 70 neonates were discharged/survived and 11(12.9%) died. Similar outcome was observed in the study conducted by Islam A et al[5]. Whereas in the study conducted by Rahman F et al[15] and Adebami OJ et al[16]. Few of the related studies were reported.[17-19] . Higher mortality was observed which was because of outborn babies were more than inborn, low birth weight and suffered from respiratory distress, apnoea, cyanosis, feed intolerance.

Conclusion:

Apgar score at 1min. has strong positive correlation with serum sodium and calcium levels at <12 and 24-48 hours. It was observed that as the severity of HIE increases sodium, calcium levels decreased and potassium levels increased.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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