CLINICAL PROFILE, AETIOLOGY & EEG CHARACTERISTICS OF NEONATAL SEIZURES

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ABSTRACT

BACKGROUND

Seizures are a common neonatal neurologic emergency, affecting approximately 1-4 per 1000 live births. The first 28 days of life (defining the neonatal period) represents the period of greatest seizure hazard during human life span.

The aim of the study is to evaluate the aetiology, clinical profile and EEG profile neonatal seizures.

MATERIALS AND METHODS

A prospective Hospital based observational study was conducted including 205 neonatal infants presenting with seizures in Government Tertiary Teaching Hospital, Kozhikode, Kerala for a period of one year between January 1, 2008 and December 31, 2008 (1 year). The demographic data, clinical presentations, laboratory reports and result of treatment were observed, analysed and reported.

RESULTS

205 new born infants were admitted in NICU with seizures. 17,121 babies including inborn and out born infants took treatment in this Hospital. Out of which 205 infants who developed seizures were included in this study. The incidence of seizures is 4.2 per 1000 among inborn babies. There were 126 male infants and the remaining 79 female infants. The gestational age of the mother was full term in 183 (89.3%) and only 2% of the babies were less than 32 weeks of gestation. The antenatal risk factors leading to seizures in infants was none in 169 (82.4%) mothers. 131 (63.9%) infants were born by normal delivery, by lower segment caesarean section in 47 (22.9%), vacuum extraction in 13 (06.3%) and forceps delivery & assisted breach in 07 (3.4%) of the infants. The birth weight was more than 2500 grams in 144 (70.24%), 2000 to 2500 grams in 40/205 infants (19.51%) and 100 to 2000 grams in 18 (08.78%) infants.

CONCLUSION

The overall incidence of neonatal seizures in babies born in our hospital was 4.2 per 1000 live births. Perinatal asphyxia was the most common cause of neonatal seizures, followed by hypoglycaemia. Tonic seizures were the most common type of seizures followed by subtle seizures. Among the babies whose EEG was done, abnormal EEG was recorded in 9.5%. Mortality was highest in babies who developed seizures in first 24 hours of life and in babies born by assisted breech delivery.

KEYWORDS

Neonatal, seizures, EEG, Pyrexial and Paediatric.

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BACKGROUND

Seizures are a common neonatal neurologic emergency, affecting approximately 1-4 per 1000 live birth.[1-4] The first 28 days of life (defining the neonatal period) represents the period of greatest seizure hazard during human life span. There is a peak in life time incidence of seizures in the first months of life.[4] One reason is that the immature brain is uniquely vulnerable to developing seizures, because the development of inhibitory neuronal circuits lags behind the excitatory networks.[5] In addition, neonatal seizures are nearly always "secondary to" or "symptomatic of" an underlying cerebral insult or stress.[3-4] Seizures in neonates have features that are unique compared with those occurring in older infants and children. Neonatal seizures are difficult to investigate and consequently determination of aetiology and initiation of therapy may be delayed which results in poor neurological outcome. There are various causes for neonatal seizures like HIE, ICH, meningitis, hypoglycaemia, congenital malformations etc. EEG provides a useful non-invasive adjunct to clinical assessment of cerebral function in neonates. In neonatal seizures, EEG has proved to be of significant prognostic value. Yet its interpretation is influenced by variations in normal maturation process of the brain. It is well recognized that not all seizures can be picked up by surface recorded EEG and many clinically silent electrographic seizures have been reported. Neonatal seizures are the most common overt

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manifestation of neurological dysfunction in neonates.[6] The most important factor that predicts their outcome is the underlying etiology.[7] The immature neonatal brain is more excitable than that of an older child. This excitability allows for synaptogenesis and learning but decreases the threshold for seizure activity.[8] Some data suggest that neonatal seizures may predispose these infants to learning difficulties and increased seizure activity later in life.[9] Hypoxic ischemia is the most common cause of neonatal seizures, results in a sharp decrease in energy production, causing a failure of the sodium-potassium pump. In addition, hypocalcaemia and hypomagnesaemia can alter membrane potential, producing sodium influx and depolarization. Therefore, the present study was conducted to evaluate the clinical, etiological and EEG profile of neonatal seizures.

MATERIALS AND METHODS

Type of Study

Hospital based descriptive study

Institute of the Study

Neonatal ICU, Institute of Maternal and Child health, Government Medical College, Calicut.

Period of the Study

From January 1, 2008 to December 31, 2008 (1 year).

Ethical Committee Clearance

An institutional ethical committee clearance was obtained for this study and committee approved proforma was used for collecting the data.

Inclusion Criteria

1. Neonatal infants with onset of seizures within first 28 days of life.
2. Infants whose seizures were identified by mother/ resident / referring doctor.

Exclusion Criteria

1. Neonatal infants with onset of seizures after 28 days of life.
2. Neonatal infants born to mothers with diabetes mellitus, eclampsia, pre-eclampsia and malignant hypertension. The information of all the neonates enrolled in the study were collected and recorded in a proforma.

A. Baseline Characteristics

Sex, Inborn/ out born, Gestational age, Maternal age, Weight, head circumference and length were measured at birth by standard techniques.

B. Clinical Profile of Seizure

Details about the seizure episodes were recorded and relevant data was collected: Age of onset of seizures in days, type of seizures, associated autonomic changes: HR and RR and Medications to control seizure.

C. Determination of Aetiology

Antenatal history including infections, drug intake, PIH, GDM etc., were noted, Type of delivery, Foetal distress (evidenced by foetal heart rate abnormalities), Presence of meconium stained liquor, APGAR at 5', Method of resuscitation, Presence of any obvious congenital anomaly.

D. Investigations

In all babies enrolled into study, the following essential investigations were done: RBS; (value less than 40 mg/dL was hypoglycaemia and value more than 125 mg/dL was hyperglycaemia), S. Calcium; (total serum Calcium of less than 7 mg/dL was hypocalcaemia), S. Magnesium(values less than 1.6 mg/dL was hypomagnesaemia), S. sodium (<135 mg/dL was hypernatremia and more than 145 was hypernatremia), S. Potassium (<3.5 mg/dL was hypokalaemia and >5.5 mg/dL was hypokalaemia), Blood urea and S. creatinine(normal age appropriate reference ranges were taken). Additional investigations were done guided by history, physical examination and essential investigations. They included: Sepsis screen (CRP > 4 mg/dL was considered positive), Blood culture and sensitivity, CSF study, TORCH serology and USG cranium/CT scan head/ MRI brain as indicated.

Electroencephalography (EEG)

EEG was done before discharge, when the neonate became stable. It was obtained from the Department of Neurology, Calicut Medical College and was interpreted by the Neurologist. All babies were treated using standard treatment protocols. Details of the treatment were also noted. All the babies were examined daily and at discharge, the general condition of the babies was noted.

Statistical Analysis

The data were entered into computer in Microsoft Excel and were analysed using SPSS 10 software using appropriate statistical tests.

RESULTS

During the study period, a total number of 205 babies were admitted in NICU with seizures. 17121 babies were born live in our hospital, out of which 205 developed seizures. The incidence of seizures is 4.2 per 1000 among inborn babies. Out of 205 new borns infants included in the present study who developed seizures, there were 126 male infants and the remaining 79 female infants (Table 1, Fig. 1).

Gender	Frequency (n=205)	Percentage
Male	126	61.5%
Female	79	38.5%

Table 1. Showing the Gender Distribution of Infants- (n-205)

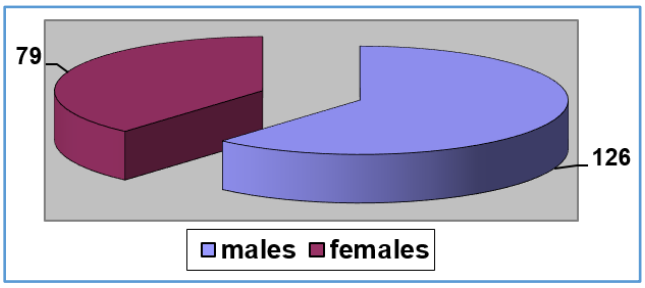

Figure 1. Showing the Gender Incidence of the Study Group (n-2015)

Present study showed majority of the infants 133 (64.9%) were referred from peripheral centers whereas 72 infants (35.1%) were included from the hospital inflow of patients (Table 2).

Place of Delivery	Frequency (n= 205)	Percentage
Inborn	72	35.1%
Out born	133	64.9%

Table 2. Showing the Place of Birth- In or Outside Hospital (n-2015)

The gestational age of the mother was observed and found that most of the babies 183 (89.3%) were born at full term. Only 2 % of the babies were less than 32 weeks of gestation (Table 3, Fig. 2).

Gestational Age	Frequency n= 205	Percentage
Term	183	89.3%
35-37 weeks	11	5.4%
32-34 weeks	7	3.3%
<32 weeks	4	2%

Table 3. Showing the Gestational Age of the Mothers (n-2015)

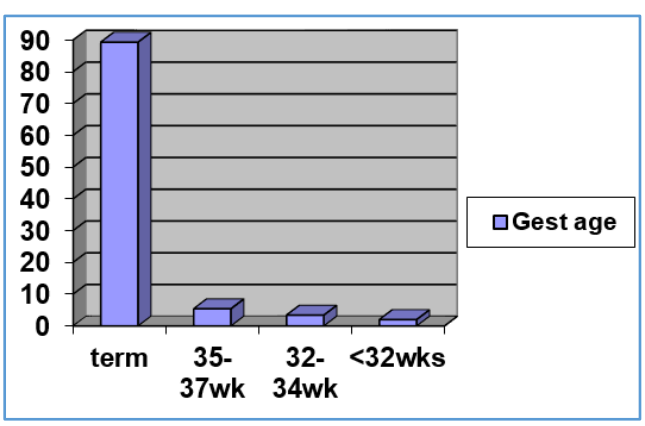

Figure 2. Showing the Gestational Age of the Mothers (n-205)

The antenatal risk factors in the mother leading to seizures in the infants were observed and found that there were none in 169 (82.4%) mothers (Table 4).

Antenatal Risk Factors	Frequency n= 205	Percentage
None	169	82.4%
Pregnancy Induced Hypertension- PIH	20	09.8%
Gestational Diabetes Mellitus- GDM	06	02.9%
Premature Rupture of Membranes- PROM	04	01.9%
More than one	06	02.9%

Table 4. Showing the Incidence of Antenatal Risk Factors (n-205)

The type of delivery was observed in this study showed that majority of the babies 131 (63.9%) were born by normal delivery, by Lower segment caesarean section was observed in 47 (22.9%), vacuum extraction in 13 (06.3%) and forceps delivery & Assisted breach in 07 (3.4%) of the infants (Table 5).

Type of Delivery	Frequency (n= 205)	Percentage
Normal	131	63.9%
LSCS	47	22.9%
Vacuum	13	06.3%
Forceps	07	03.4%
Assisted breech	07	03.4%

Table 5. Type of Delivery of Infants in the Study (n-205)

The present study showed necessity of some form of resuscitation at birth in 79/205 (38.53%) infants. Meconium stained amniotic fluid (MSAF) in 22/205 (10.73%) of infants with seizures (Table 6).

Particulars	Frequency	Percentage
Resuscitation at birth(n=198)	79	38.53%
MSAF	22	10.73%

Table 6. Incidence of Resuscitation Required in the Study Group (n-205)

46 (58.22%) of the infants who were resuscitated in this study required resuscitation with endotracheal intubation (ET). 19 (24.05%) of the infants required bag mask ventilation (BMV) and 14 needed simple head positioning and suctioning (Table 7).

Method of Resuscitation	Frequency	Percentage
Positioning and suction	14	17.72%
BMV	19	24.05
ET intubation	46	58.22%

Table 7. Method of Resuscitation used among the Resuscitated Infants (n-79)

The present study showed infants with birth weight more than 2500 grams in 144 (70.24%), 2000 to 2500

grams in 40/205 infants (19.51%) and 100 to 2000 grams in 18 (08.78%) infants (Table 8, Fig. 3).

Birth Weight	Frequency (n= 205)	Percentage
<1000 gms	-	-
1000-1500 gms	04	02%
1500-2000 gms	18	08.78%
2000-2500 gms	40	19.51%
2500 or more	143	70.24%

Table 8. Showing the Birth Weight among the Study Group Infants (n-205)

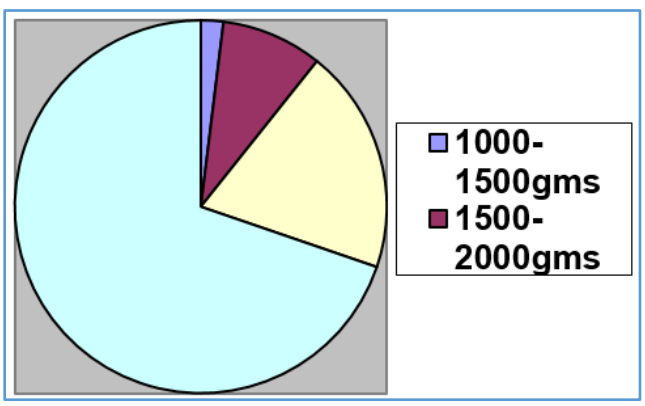

Figure 3. Showing the Birth Weight of the Infants (n-205)

The time of onset of seizures in the study group was observed to be within 24 hours in 81 infants (39.5%), between 24 to 72 hours in 79 (38.5%) and between 4 to 28 days in 45 (22%) infants (Table 9).

Onset of Seizures	Frequency (n= 205)	Percentage
< 24 hours	81	39.5%
24-72 hours	79	38.5%
4- 28 days	45	22%

Table 9. Onset of Seizures in the Study Group (n-205)

Among the type of seizures tonic type were observed in 93 (45.4%), focal clonic in 27 (13.1%), multifocal clonic in 12 (05.8%), subtle in 39 (19%) and combination type in 32 (15.6%) infants (Table 10).

Type of Seizures	Frequency (n= 205)	Percentage
Tonic	93	45.4%
Focal clonic	27	13.1%
Multifocal clonic	12	05.8%
Subtle	39	19%
Myoclonic	02	00.01%
Combination types	32	15.6%

Table 10. Showing Type of Seizures Observed in the Study Group- (n-205)

Septic screen was positive in 81 (39.5%) infants, TORCH positive in 1 (05.3%) infants. Normal CSF study was observed in 160 (91.4%) infants. Congenital malformations were identified in 05.4% of the infants (Table 11).

Particulars	Frequency	Percentage
Positive septic screen (n= 195)	81	39.5%
Normal CSF study (n= 175)	160	91.4%
Congenital malformations (n=205)	11	05.4%
TORCH positive (n= 19)	01	05.3%

Table 11. Showing Lab Investigation (n-205)

In 178/205 infant's blood was sent for culture and sensitivity. It was observed that 149/178 (83.75%) infants had their blood culture reports negative. Staph. Aureus was reported in 18/178 samples (10.11%). E. coli was seen in 05 (01.68%) of the samples (Table 12).

Blood (Culture and Sensitivity)	Frequency n= 178	Percentage
Sterile	149	83.7%
Staph. aureus	018	10.11%
E coli	005	02.80%
Klebsiella	003	01.68%
Acinetobacter	003	01.68%

Table 12. Showing Culture Sensitivity of Blood Samples (n-178)

In this study Hypoglycaemia was observed in 44 (21.5%) of the infants, hypocalcaemia in 03 (1%) and hypomagnesaemia in 39 (19%) of the infant's blood samples (Table 13).

Particulars	Frequency	Percentage
Hypoglycaemia (n= 205)	44	21.5%
Hypocalcaemia (n=198)	02	1%
Hypomagnesaemia (n=165)	39	19%

Table 13. Showing the Metabolic Changes in the Study Group (n- 85)

Among the 130 CT scan of head taken in the study group, it was observed that 63 scans were normal. SAH was observed in 21 (16.0%), HIE in 19 (14.6%), brain oedema & IVH in 11 (08.64%) CT head scan findings (Table 14).

CT Scan Head Findings	Frequency n= 130	%
Normal	63	48.4%
Sub Arachnoid Haemorrhage (SAH)	21	16.0%
Hypoxic Ischemic Encephalopathy (HIE)	19	14.6%
Brain oedema	11	08.4%
Intra Ventricular Haemorrhage (IVH)	11	08.4%
Hematoma	03	2.30%
Hydrocephalus	01	0.77%
Arnold Chiari formation	01	0.77%

Table 14. Showing the Findings of CT Scan Head in the Study Group (n- 130)

EEG was done in 148 infants in this study. EEG was normal in 134 infants and abnormal in 14 infants (09.5%), (Table 15).

EEG	Frequency (n= 148)	Percentage
Normal	134	90.5%
Abnormal	14	9.5%

Table 15. EEG Profile Observed in the Study Group-n-148

Phenobarbitone was used to control seizures in 135 infants (65.80%), Phenytoin in 60 (29.26%) infants, Dextrose in 05 (02.44%) in this study (Table 16).

Medications to Control Seizures	Frequency n= 205	Percentage
Phenobarbitone	135	65.8%
Phenytoin	60	29.26%
Dextrose	05	02.44%
Pyridoxine	03	01.46%
Calcium	01	00.49%
Midazolam	01	00.49%

Table 16. Medications to Control Seizure

Perinatal asphyxia was observed in 80 (39%) infants, Hypoglycaemia in 38 (18.50%), Intracranial bleeding in 15 (07.30%), Sepsis in 07 (03.40%) and Meningitis in 06 (02.90%) in this study (Table 17).

Aetiology	Frequency (n= 205)	Percentage
Perinatal asphyxia	80	39%
Hypoglycaemia	38	18.5%
Intracranial bleed	15	7.3%
Sepsis	07	3.4%
Meningitis	06	2.9%
Others	04	02%
Bilirubin encephalopathy	03	1.5%
CNS malformation	02	01%
Pyridoxine dependant seizures	02	01%
Unknown	42	20.5%
Multiple aetiologies	06	2.9%

Table 17. Etiological Factors Observed in this Study (n-205)

The most common type of seizures in both term and preterm was tonic seizures. The P value for the above observation was 0.329 (Table 18).

Gestational Age	Type of seizures					
	Tonic	Focal Clonic	Multifocal Clonic	Subtle	Myoclonic	Multiple Types
Term	78 (42.6%)	21 (11.4%)	12 (6.5%)	39 (21.3%)	2 (1.1%)	31 (16.9%)
Preterm	15 (68.2%)	6 (27.2%)				1 (4.5%)

Table 18. Type of Seizures in Term/ Preterm Mother's Gestational Age (n-205)

There was no statistical difference in the final outcome in infants with seizures, between Inborn births and out born births; the p value was 0.767 (p taken as significant at <0.050). The final outcome of infants with abnormal EEG had a poor prognosis when compared to those with normal EEG (P value 0.049). Similarly the foetal distress at birth was a risk factor in neonatal seizures with p value at 0.001 (Table 19).

Particulars		Outcome	P value
		Expired	
Place of birth	Inborn	16 (22.2%)	.767
	Out born	32 (24.1%)	
Foetal distress	Yes	20 (42.6%)	<0.001
	No	26 (16.8%)	
EEG	Normal	1 (0.7%)	0.049
	Abnormal	1 (7.1%)	

Table 19. Final Outcome in the Prognosis of the Study Group (n-205)

Analysing the type of delivery as a risk factor in causing neo-natal seizures in this study, it was observed that there was significant difference in outcome of babies born by various modes of delivery. The worst outcome was observed for assisted breech delivery with 6/7 infants expired (85.7% expired) the P value was 0.003 (Table 20, Fig. 4).

Delivery Type	Outcome	
	Alive	Expired
Normal-131	102 (77.9%)	29(22.1%)
LSCS- 47	38(80.9%)	9(19.1%)
Vacuum- 13	11(84.6%)	2(15.4%)
Forceps- 07	5 (71.4%)	2(28.6%)
Assisted breech- 07	1(14.3%)	6(85.7%)

Table 20. Influence of Type of Delivery on the Prognosis of Seizures (n-205)

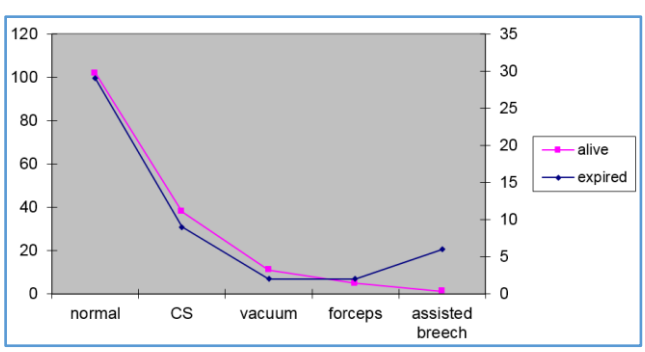

Figure 4. Showing the Influence of Type of Delivery on the Prognosis of Seizures (n-205)

There was a significant difference in the outcome of babies depending on the time of onset of seizures. 42% of those babies with seizures within 24 hours of birth expired compared to 22.2% of babies who developed seizures after 72 hours; (P value < 0.001), (Table 21 & Fig. 5).

Onset of Seizures	Outcome	
	Alive	Expired
<24 hours	47(58%)	34(42%)
24-72 hours	75(94.9%)	4(5.1%)
4- 28 days	35(77.8%)	10(22.2%)

Table 21. Time of Onset of Seizures Influencing the Final Outcome on the Prognosis of Seizures (n-205)

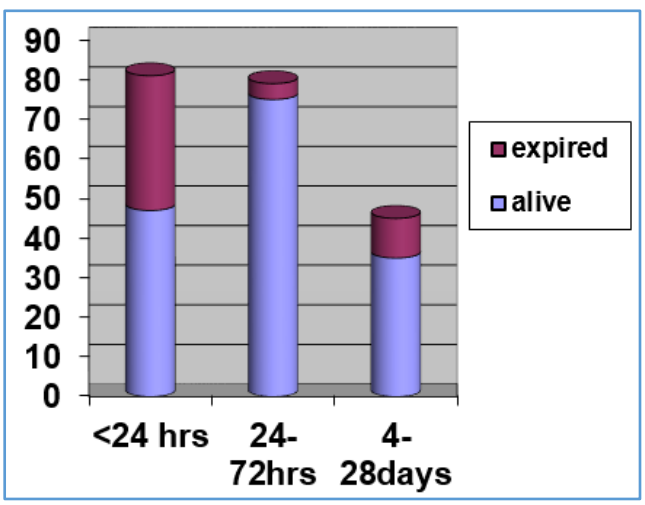

Figure 5. Showing the Time of Onset of Seizures Influencing the Final Outcome on the Prognosis of Seizures (n-205)

The outcome of the babies was directly related to the birth weight. All the babies with birth weight between 1000 and 1500 grams expired compared to 24% of babies with birth weight more than 2500 gms; (p value <0.001), (Table 22).

Birth Weight	Outcome	
	Alive	Expired
<1000 gms	-	-
1000-1500 gms	-	4(100%)
1500-2000	10(55.6%)	8(44.4%)
2000-2500	28(70%)	12(30%)
2500 or more	119(83.2%)	24(16.8%)

Table 22. The Final Outcome of Seizures in Relation to Birth Weight of Infants (n-2015)

More than half of the cases of perinatal asphyxia had onset of seizures within first 24 hours of birth. 81.6% of babies with hypoglycaemia had seizures between 24 to 72 hours of birth. The P value was <0.001 (Table 23).

Aetiology	Onset of Seizures		
	<24 hrs.	24-72 hrs	>72 hrs.
Perinatal asphyxia	63(78.8%)	14(17.5%)	03(03.8%)
Hypoglycaemia	01(02.6%)	31(81.6%)	06(15.8%)
Intracranial bleed	06(40%)	08(53.3%)	01(06.7%)
Unknown	06(14.3%)	15(35.7%)	21(50%)
Sepsis	01(14.3%)	04(57.1%)	02(28.6%)
Meningitis	-	01(16.7%)	05(83.3%)
CNS malformation	-	01(50%)	01(50%)
Pyridoxine dependant seizures	-	02(100%)	-
Bilirubin encephalopathy	-	-	03(100%)
Others		01(25%)	03(75%)
Multiple aetiologies	04(66.6%)	02(33.3%)	-

Table 23. Showing the Different Aetiological Factors and Corresponding Time of Onset of Seizures (n-205)

The most common type of seizures in perinatal asphyxia was tonic type (66.7%). Subtle seizures were the most common type of seizures in hypoglycaemia (44.7%), (Table 24.

Aetiology	Type of Seizures					
	Tonic	Focal Clonic	Multifocal Clonic	Subtle	Myoclonic	Multiple Types
Perinatal asphyxia	50 (66.7%)	09 (11.25%)		04 (5%)		17 (44.7%)
Hypoglycaemia	11 (28.9%)	08 (10.5%)		17 (44.7%)		02 (5.2%)
Intracranial bleed	10 (66.7%)	03 (20%)				02 (13%)
Unknown	12 (28.6%)	10 (23.8%)	2 (2.4%)	12 (28.6%)	1 (2.3%)	05 (11.9%)
MODS and sepsis	01 (14.3%)	01 (14.3%)		01 (14.3%)		04 (57.1%)
Meningitis	02 (33.3%)	01 (16.7%)	02 (33.3%)	01 (16.7%)		
CNS malformation	02 (100%)					
Pyridoxine dependant seizures	02 (100%)					
Bilirubin Encephalopathy	02 (66.7%)		1 (33.3%)			
Others				02 (50%)	1 (25%)	01 (25%)
Multiple aetiologies	01 (16%)	01 (16%)		02 (32%)		2 (32%)

Table 24. Showing the Type of Seizures in Various Aetiological Factors in the Study (n-205)

Abnormal EEG was seen in 8 babies (17.8%) with perinatal asphyxia (Table 25).

Aetiology	Cases	No. of babies with EEG done	No. of babies with Abnormal EEG
Perinatal asphyxia	80	45	08(17.8%)
Hypoglycaemia	38	33	01(3%)
Intracranial bleed	15	12	01(8.3%)
Unknown	42	35	-
MODS & sepsis	07	05	-
Meningitis	06	05	-
CNS malformation	02	01	-
Pyridoxine dependant seizures	02	02	02(100%)
Bilirubin encephalopathy	03	02	-
Others	04	04	02(50%)
Multiple aetiologies	06	04	-

Table 25. Showing the Incidence of Abnormal EEG in this Study (n-205)

The EEG abnormality was multifocal in most of the infants (85%). Burst suppression was observed in 4 babies (28.5%), (Table 26).

Abnormality in EEG	Frequency (n=14)	Percentage
Background	06	42.8%
Burst suppression	04	28.5%
Spikes/ sharps	04	28.5%
Focal	02	14.2%
Multifocal	12	85%

Table 26. Showing the Abnormal EEG Findings in the Study (n-205)

DISCUSSION

In most clinical situations neonatal seizures are identified by clinical observation. However, some of the clinically identified motor and behavioural phenomena do not have simultaneous EEG correlate thus over estimating the incidence of neonatal seizures. Conversely many electrographic seizures are not accompanied by clinically observed alterations in neonatal motor or behavioural function thus underestimating neonatal seizures. The incidence of neonatal seizures as reported in various studies range from 0.1-0.5% in term neonates and 10-22. 7% in preterm neonates.[9-11] Seizures affect approximately 1-4 per 1000 live births.[1-4] in the present study the overall incidence of 4.2 per 1000 live births in babies born in our hospital. 89.3% of the babies in this study were born at term. In the study by Saliba,[3] J. Fred Annegers,[4] they had 20% increased risk of developing seizures compared to females.[12] In the present study 61.5% of the babies were males. Most of the infants (82.4%), who developed seizures, did not have any Antepartum risk factors. This is in contrast to a study conducted by Nadia Badawi, Jennifer J Kurinczuk, John M Keoghe, et al in Western Australia, in which many maternal antenatal factors were identified as risk factors of neonatal encephalopathy, including maternal thyroid disease, severe preeclampsia, moderate or severe bleeding and a clinically diagnosed viral infection. The role of perinatal infection is of considerable aetiological interest in neurological dysfunction in preterm[13] and term[14] infants. In addition to the well-known viral teratogens (rubella, cytomegalovirus) other viruses may be teratogenic or other mechanisms may operate - such as hyperthermia, inflammatory mediators, or other pathophysiological responses. Due to economic constraints, screening for intrauterine infections could not be done universally in all babies admitted in our unit. This may be the reason for the under diagnosis of perinatal infections. Birth weight is a strong predictor of the risk of neonatal seizures.[15-17] In our study 30.4% of the subjects were Low Birth Weight (LBW) infants. The incidence of seizures in LBW babies born in our hospital was 20 per 1000 live births in contrast to 4.2 per 1000 live birth in full term infants. The risk of neonatal seizures varies inversely with birth weight. In a study by Holden KR, Mellitus G and Freeman KM, the incidence of seizures was 63% in LBW compared to 37% in babies with birth weight more than 2500 grams.[18] Although the risk of seizures was highest among premature infants and LBW, full term infants constituted the majority of cases of neonatal seizure in our study population. Mortality due to neonatal seizures was directly related to the birth weight of the babies. All the four babies (100%) with a birth weight less than 1500 gms expired. The reported effect of maternal age on the risk of newborn seizures has been inconsistent.[19,20] In our study 97% of babies were born to mothers in the age group of 18 to 34 years. Meconium staining of amniotic fluid occurred only in 10.9% of babies with seizures. In the Dublin collaborative study conducted by P D Curtis, T G Mathews, T A Clarke et al, meconium staining did not occur in half the babies with seizures.[21] Most of the infants in this study who developed seizures were born by normal delivery. In the Dublin study,[21] infants who developed seizures were more likely to be borne by LSCS or assisted breech delivery. In our study 85.7% of babies born by assisted breech and 19.1% born by LSCS expired. Caesarean section and assisted delivery were associated with seizures in previous studies.[12,22] Seizure types in newborn babies vary widely from those observed in older infants. The type of seizure also differs in term and preterm babies. In our study the most common form of seizure was tonic (45.4%) in both term and preterm babies, followed by subtle seizures (39%), focal clonic (9.8%) and Myoclonic seizures (1%). Ajay Kumar, Ashish Gupta and Bibek Talukdar, from Maulana Azad Medical College, New Delhi, have reported multifocal clonic seizures as the most common type of seizures in their study.[23] Mizrahi and Kellaway[24] and Scher et al,[25] have reported subtle seizures as the most common type of seizures in their studies. Ross AL et al,[26] studied 118 babies, out of which 48 (40.60%) had subtle, 42 (35.59%) had clonic seizures, 10 (8.9%) had generalized tonic and 28 (27.78%) had Myoclonic type of seizures. Soni A et al[27] reported that the commonest type of seizures in term group was tonic seizures seen in 15 babies (37.5%) and subtle

seizures seen in 10 (25%) babies. In the preterm group also the commonest type of seizures observed was tonic (41.6%) seizures followed by subtle seizures (33.3%). In our study, we have obtained similar results. Perinatal asphyxia is the most common cause of neonatal seizures. In various studies the reported incidence was 15-53%.[28,29] Similarly in the present study perinatal asphyxia is the most common cause of neonatal seizures, constituting 39% of the total. Sood A et al[30] and Kumar A et al[31] reported that birth asphyxia as aetiology of seizure was seen in 45.71% and 48.27% cases respectively. The characteristic time of onset of seizures in perinatal asphyxia is 8-36 hours of birth.[9] 78.8% of babies with perinatal asphyxia in our study, developed seizures within the first 24 hours of birth. In babies with perinatal asphyxia as the sole cause of seizures, the most common type of seizures noticed was tonic seizures (66.7%) although Mizrahi and Kellaway et al[24] reported that Myoclonic seizures were present in 64.7% of babies with perinatal asphyxia. Incidence of hypoglycaemia reported in literature varies from 2 to 26%.[29,32] The incidence of seizures due to hypoglycaemia was 18.5% in this study. Sood A et al[30] demonstrated that hypocalcaemia and hypoglycaemia were most common metabolic abnormality. The seizures due to hypoglycaemia typically occurred on neonatal day 2nd 6. Similarly, in the present study 81.6% occurred between 24-72 hours of birth. 44.7% had subtle seizure, which was the most common type observed in this study, in contrast to multifocal clonic in the study by Ajay Kumar et al.[23] The incidence of hypocalcaemia seizures ranges from 1.1% to 22%.[33] In our study only 1 out of the 205 babies had hypocalcaemia seizures (0.4%), per se. Another baby with perinatal asphyxia was also detected to have hypocalcaemia. The lower incidence of hypocalcaemia in our study may be due to the fact that ionized calcium could not be done as routine in babies, due to financial constraint. Also, babies who are at risk for developing hypocalcaemia (HIE, preterm, IDM) are given prophylactic calcium in our unit. Late onset hypocalcaemia is also uncommon because most babies are exclusively breast fed. Hypomagnesaemia was detected in 19%, in our study. In a study by Sood A et al[30] out of 29 babies with metabolic abnormalities, 17.24% had hypomagnesaemia. Ross AL et al[26] studied 144 babies of which 13 (9.5%) babies had septicaemia. In our study 3.4% had Sepsis and 2.9% had meningitis. Pyridoxine dependent seizures were observed in 2 babies and both of them had associated EEG abnormalities. Coen RW et al[34] found that 81% of babies had early onset seizures (<72 hrs). Ross AL et al[26] also found early onset seizures in 75 (50.33%) babies. 78% of the babies in this study also had seizures in the first 72 hours of birth. 39.5% had seizures in the first 24 hours of birth. 65.8% of the babies had their seizures controlled with Phenobarbitone. According to the recent literature, current clinical practice most often includes empiric treatments with Phenobarbital as first line for confirmed or suspected seizures in the newborn. (6, 7 and 36). In the Dublin collaborative study,[21] low Apgar scores at one minute and 5 minutes and the need for intubation for longer than 10 minutes at birth, were significantly associated with a poor outcome. In our study 63.5% of the babies who developed seizures required an endotracheal intubation at birth. EEG was obtained in 148 out of 205 babies. EEG was abnormal in 14 babies (9.5%). EEG evidence of diffuse cerebral injury like burst suppression, multifocal sharp waves, dysmaturity, attenuation of background and electrical silence is seen in HIE and meningitis (9) but exact incidence of these findings have not been established. In the present study out of 45 EEG'S done in perinatal asphyxia 8 were abnormal (17.8%). This is in comparison with the study by Ajay Kumar et al in which abnormal EEG in HIE was noted in 8 out of 30 babies (26.6%).[23] In the study by Rose and Lombroso[34] and Mirzahi and Kellaway 27 EEG abnormalities in standard EEG in HIE were noted in 70% and 46.3% of cases. The difference in the present study could be attributed to the variation in the time at which EEG was taken, the electrodes used for EEG recording and the quality of EEG machine. In neonatal hypoglycaemic seizures EEG produces multifocal discharges. However, there is no systematic study available showing incidence of EEG changes in hypoglycaemia. Most of these observations are based on individual case reports. In the present study out of 33 EEGs done, only 1 was found to be abnormal (3%). Abnormal EEG record in standard EEG in hypoglycaemia was reported to be 42.9% by Rose and Lombroso[34] and 4.9% by Mirzahi and Kellaway.[26] Abnormal record in standard EEG in hypocalcaemia has been reported in 27.8% by Rose and Lombroso.[34] In our study abnormal EEG was observed in the baby with hypocalcaemia in the form of spike discharges. EEG was done in 5 out of 7 babies with MODS and sepsis and meningitis respectively. Abnormal standard EEG in meningitis with or without sepsis was also reported in 33.3% cases by Rose, Lumbroso and Hunt R W[34,35] and by Mizrahi and Kellaway[24] in 17%. 49 out of the total 205 babies expired (23.9%). In the Dublin collaborative study,[21] 18% of babies with seizures died. The main cause for death in this study was perinatal asphyxia. The reported incidence of undetermined aetiology of clinical seizures varies from 2.4% to 5.3%.[24] In a study by Jennifer M Kwon, Ronnie Guillet, Golisano Children's Hospital, NY, out of 180 babies studied half (49%) had unclear aetiology.[36] In the study by Ajay Kumar et al cause could not be ascertained in 14.44% of babies.[23] In the present study cause could not be identified in 42 babies (20.5%). Possible reasons could be non-availability of in- house imaging facilities, EEG facilities, facilities for metabolic work up and the short period survival between first seizure episode and death.

Limitations

However, there are certain limitations to this study such as: ionized Calcium estimation could not be done in all babies. MRI was not freely available during the time period of the study. Detailed metabolic work up could not be done for all infants with unidentified aetiology.

CONCLUSION

The overall incidence of neonatal seizures in babies born in our hospital was 4.2 per 1000 live births. Perinatal asphyxia was the most common cause of neonatal seizures, followed

by hypoglycaemia. Tonic seizures were the most common type of seizures followed by subtle seizures. Among the babies whose EEG was done, abnormal EEG was recorded in 9.5%. Mortality was highest in babies who developed seizures in first 24 hours of life and in babies born by assisted breech delivery. A definite aetiology could not be determined in 20.5% of babies.

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