

## Electroencephalogram abnormalities in full term infants with history of severe asphyxia

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### Abstract

**Background** An electroencephalogram (EEG) is an electroimaging tool used to determine developmental and electrical problems in the brain. A history of severe asphyxia is a risk factor for these brain problems in infants.

**Objective** To evaluate the prevalence of abnormal EEGs in full term neonates and to assess for an association with severe asphyxia, hypoxic ischemic encephalopathy (HIE), and spontaneous delivery.

**Methods** This cross-sectional study was conducted at the Pediatric Outpatient Department of Sanglah Hospital, Denpasar, from November 2013 to January 2014. Subjects were full-term infants aged 1 month who were delivered and/or hospitalized at Sanglah Hospital. All subjects underwent EEG. The EEGs were interpreted by a pediatric neurology consultant, twice, with a week interval between readings. Clinical data were obtained from medical records. Association between abnormal EEG and severe asphyxia were analyzed by Chi-square and multivariable logistic analyses.

**Results** Of 55 subjects, 27 had a history of severe asphyxia and 28 were vigorous babies. Forty percent (22/55) of subjects had abnormal EEG findings, 19/22 of these subjects having history of severe asphyxia, 15/22 had history of hypoxic-ischemic encephalopathy (HIE), and 20/22 were delivered vaginally. There were strong correlations between the prevalence of abnormal EEG and history of severe asphyxia, HIE, and spontaneous delivery.

**Conclusion** Prevalence of abnormal EEG among full-term neonates referred to neurology/growth development clinic is around 40%, with most of them having a history of severe asphyxia. Abnormal EEG is significantly associated to severe asphyxia, HIE, and spontaneous delivery. [Paediatr Indones. 2015;55:297-301].

**Keywords:** EEG, asphyxia, full term neonates

Electroencephalography is a noninvasive procedure to detect electrical activity disorders in the brain.<sup>1,2</sup> Abnormal EEGs in full term babies can be due to many factors such as birth trauma, intracranial infection, systemic infection that affects the brain, asphyxia, inborn errors of metabolism, congenital defects that impair central nervous system (CNS) function like Down's syndrome, and other unknown etiologies.<sup>3</sup> In neonatal asphyxia, cerebrovascular changes result in neuronal damage.<sup>4</sup> Conde et al. showed that 3% of vigorous, full term newborns had abnormal EEG findings.<sup>5</sup>

Caravale et al. performed EEGs on 77 infants with asphyxia in their first week of life, 52 of whom had normal EEG findings. At 1 year of age, 83% had normal findings, 17% had mild abnormalities, and none had severe abnormality.<sup>1</sup> To our knowledge, abnormal EEG prevalence in full term infants and its association with severe asphyxia has not been studied in Bali, Indonesia, to date. The objectives of this study were to determine the abnormal EEG prevalence in 1 month-old, full term infants, with and without a history of severe asphyxia and to assess for possible

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associations between abnormal EEG and severe asphyxia, as well as hypoxic ischemic encephalopathy (HIE), and spontaneous delivery.

## Methods

This cross-sectional study was conducted in the Pediatric Neurology, Growth and Development Outpatient Department at Sanglah Hospital, Denpasar from November 2013 to January 2014. Subjects were full term infants aged 1 month referred to the neurology/growth and development outpatient clinic. They were recruited by consecutive sampling. The inclusion criteria were 1-month-old babies born full term who were delivered and/or hospitalized at Sanglah Hospital, a tertiary hospital in Denpasar, Indonesia. Subjects' parents provided informed consent. We excluded patients with a history of sepsis, intracranial infections, congenital anomalies, inborn errors of metabolism that affect the CNS, neonatal seizures with unsure/unknown etiology, or head trauma. This study was approved by Ethics Committee of Udayana University Medical School.

All subjects underwent EEG using Nicolet REF

515-019000 rev 02 with 10-20 system and 32 montages. The EEGs were interpreted by a pediatric neurology consultant, twice, with a 1-week interval between readings. Clinical data were obtained from medical records. Reliability of the readings was checked by calculating Kappa statistic, which was 0.9

Data were first described in a baseline table and was presented as mean, median, or proportion as appropriate. To assess the possible associations between abnormal EEG, severe asphyxia, delivery mode, and HIE, we first performed univariable analysis using Chi-square test. We then performed multivariable logistic regression incorporating potential risk factors (severe asphyxia, mode of delivery, and HIE) for abnormal EEG. A P value < 0.05 considered to be statistically significant. We used SPSS 16.0 for Windows software for analyses.

## Results

During the study period, 144 one-month-old babies visited the Pediatric Outpatient Department at Sanglah Hospital, Denpasar. Of these infants, 63 were excluded due to the following reasons: 34 had a history

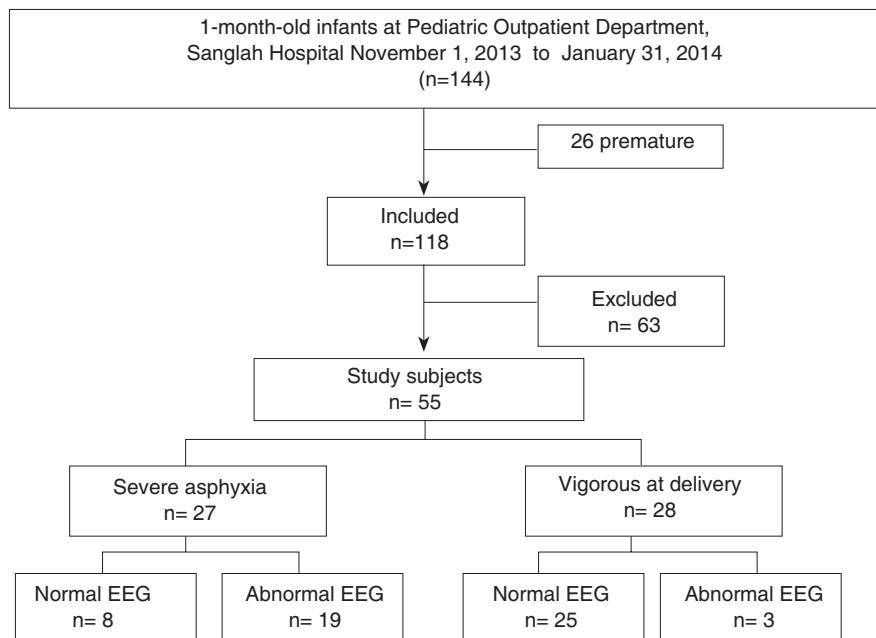


Figure 1. Study participant flow

of systemic and/or CNS infection, bleeding, congenital anomaly or metabolic disorders which affected CNS function, 5 had congenital anomaly, and 24 had parents who refused to participate (Figure 1).

Fifty-five babies were included in this study (Table 1). Hypoxic ischemic encephalopathy was diagnosed in 27%, and history of clinical seizure was found in 20%, 9% of whom were treated with anti-epileptic medication. Forty percent (22) of subjects had abnormal EEG findings, with 19/22 of these subjects having history of severe asphyxia, while the remainder infants were vigorous at birth. Most abnormal EEG showed multifocal locations (12/22) and abnormal spike waves (18/22) (Table 2). Asphyxia, HIE, and vaginal delivery mode were shown to be significantly associated with abnormal EEG both in univariable and multivariable analyses (Table 3), in

which these variables appeared to increase the risk of abnormal EEG by 16-17 fold for asphyxia (OR 16.5, 95%CI 2.1 to 133.9, P=0.008), HIE (OR 17.5, 95% CI 1.5 to 199.2, P=0.021), and vaginal delivery (OR 15.9, 95% CI 1.7 to 148.6, P = 0.015).

## Discussion

This study showed that abnormal EEG was quite common, occurring in 40% of neonates referred to the pediatric outpatient neurology/growth development clinic. This abnormal EEG was strongly associated with previous asphyxia, HIE, and vaginal delivery.

Asphyxia is the most frequent cause of neonatal seizures (51%).<sup>6,7</sup> In a previous study of 92 neonates with a history of perinatal asphyxia, 57 were diagnosed with HIE, and 61.3% of them had clinical seizures.<sup>8</sup> We found 27 subjects with perinatal asphyxia and 16 subjects with HIE. A Pakistani study on 235 asphyxia cases, reported that 85.9% cases were vaginal deliveries.<sup>9</sup> Similarly, most of our asphyxia subjects were delivered vaginally (68%). Previous studies studying the association between abnormal EEG and mode of delivery have been limited. We also found that most subjects with abnormal EEG (20/22) were delivered vaginally.

Conde et al. found that 80.4% of abnormal EEG findings were in neonates with a history of HIE and 85.3% were in neonates with severe asphyxia.<sup>5</sup> We found that 15/22 of abnormal EEGs were in subjects with history of HIE and 19/22 with severe asphyxia. Similar to the Conde et al. study, we observed that abnormal EEG findings were higher in subjects with HIE or asphyxia. Abnormal EEG was significantly associated with both history of severe asphyxia and HIE in our study.

Electroencephalography is the best method

**Table 1.** Baseline characteristics of subjects

Characteristics	(N=55)
Male gender, n (%)	35 (64)
Mode of delivery	
Normal, n (%)	26 (47)
Caesarian section, n (%)	25 (45)
Forceps, n (%)	3 (6)
Vacuum, n (%)	1 (2)
Asphyxia, n (%)	27 (49)
HIE, n (%)	15 (27)

**Table 2.** Characteristics of abnormal EEG

Characteristics	(N=22)
Location, n	
Multifocal	12
Right and left fronto-temporal	5
Right and left temporoparietal	3
Right and left frontal	1
Right centro-frontal	1
Type of wave, n	
Spike wave (epileptiform)	18
Hypofunction	4

**Table 3.** Risk factors for abnormal EEG

	Abnormal EEG		OR	Univariable		Multivariable		
	Yes n = 22	No n = 33		95%CI	P value	OR	95%CI	P value
Male gender	14	21	1	0.51 to 1.96	1*	-	-	-
Severe asphyxia	19	8	6.6	2.2 to 19.7	0.001*	16.6	2.1 to 133.9	0.008*
HIE	15	1	5.2	2.6 to 10.3	0.001*	17.5	1.5 to 199.2	0.021*
Vaginal delivery	20	10	8.5	2.5 to 32.3	0.001*	15.9	1.7 to 148.6	0.015*

\*Chi-square analysis

to predict neurological and mortality outcomes in patients with asphyxia and HIE.<sup>3,10</sup> Of our 22 subjects with abnormal EEG, 19 of them had a history of severe asphyxia. Similarly, Toet *et al.* showed that 61% of infants with severe asphyxia had abnormal EEGs.<sup>11</sup> The high number of infants with severe asphyxia (49%) may be due to the fact that Sanglah Hospital is a referral center in Bali, hence, most babies who came for consultation were not healthy. Conde *et al.* showed that abnormal EEG prevalence in vigorous babies was 3%.<sup>5</sup> We found that 11% of vigorous babies had abnormal EEGs. This difference could be due to different EEG measurement used. Conde *et al.* used amplitude integrated EEG, while we used conventional EEG. Studies showed that 5-10% of abnormal EEGs have unknown etiologies.<sup>12,13</sup>

Prasad *et al.*<sup>14</sup> showed that the most common abnormal EEG type in neonates with asphyxia and HIE was spike wave (81.5%). Similarly, 18/22 of abnormal EEGs in our study were of spike wave type. Nunes *et al.* found three frequent locations of abnormal findings in EEGs from neonates with asphyxia and HIE: the cerebral neocortex, hippocampus, and basal ganglia-thalamus, which result as multifocal discharges.<sup>15</sup> We also found that 12/22 of abnormal EEG findings were multifocal.

Our study was limited by the fact that we only performed a single EEG measurement for each baby at one month of age. Given the cross-sectional, the causal association between abnormal EEG and asphyxia/HIE was also less established although we believe that inverse causation is very unlikely as abnormal EEG could not cause any asphyxia, HIE, or determine mode of deliver. Further studies to assess EEG findings at 6 months or 2 years of age need to be conducted.

In conclusion, abnormal EEG incidence among 1-month-old infants referred to the pediatric neurology/growth development clinic is 40%, with majority of subjects having a history of severe asphyxia. Abnormal EEG has significant associations with severe asphyxia, HIE, and vaginal delivery.

### Conflict of interest

None declared.

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