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Research Article

Contribution of the Amplitude Electroencephalogram in Neonatology

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Abstract

Amplitude integrated electroencephalogram (aEEG) is a technique for monitoring brain function of which we show interest in neonatology. This is a retrospective study of 98 newborns admitted to neonatology unit at the University Hospital MOHAMED VI in Marrakech from 25th June 2012 to 1st July 2013, which benefited from a aEEG monitoring using the Olympic CFM 6000 device. The classification used was that of Al Naqeeb which defines three types of tracings. The prognostic value of aEEG was tested by the chi-square test. A $p < 0.05$ was significant. The clinical suspicion of seizures was confirmed in 57 among 66 newborns. The subclinical seizures were detected in 12 babies. 40 of the 48 babies with type I tracing had a favorable outcome, while 25 of the 50 with moderately to severely pathological trace died or developed neurological sequelae. The aEEG therefore has a predictive value in newborns with a sensitivity of 75%, specificity of 61%, positive predictive value of 50% and a negative predictive value of 83%. 8 newborns were put under hypothermia. Among 69 babies put under anticonvulsants, 60 responded to monotherapy (phenobarbital) and 9 required combination therapy. The aEEG therefore is a good diagnostic tool and therapeutic management. It also has a prognostic value in terms of survival, making it an essential tool in neonatology.

Keywords: *Amplitude Integrated Electroencephalogram; Neurological Distress; Seizures; Full-Term Newborn; Preterm Newborn*

Introduction

In neonatal intensive care, EEG is essential for the assessment of neurological status in neurological diseases of the newborn. The EEG amplitude which is a technique of monitoring, simple to use and easy to interpretation, saw its indications multiply in recent years. Established in June 2012 at the neonatal ICU of CHU Mohamed VI of Marrakech, it has been of great interest in many situations. The aim of our study will be to demonstrate the benefit of this technique for monitoring and determining its limits.

Patients and Methods

This is a retrospective study of 98 newborns admitted to the neonatal intensive care unit of the University Hospital of Marrakech Mohammed VI from 25th June 2012 to 1st July 2013, having benefited from a brain function monitoring (CFM). The device used was an Olympic CFM 6000 which records, on a bypass, the signal P3-P4 between regions of the international classification 10/20 of Jasper HH in 1958 [1]. It uses only three electrodes which arise in two different ways. We collected the data of holdings to records databases containing anamnestic, clinical and laboratory elements. In the interpretation of our tracings, we used the classification of Al Naqeeb 1999 which includes three types [2]. The presence of seizures is characterized by a sudden increase in the amplitude of the aEEG, then a return to the initial tracing at the end of the episode [3].

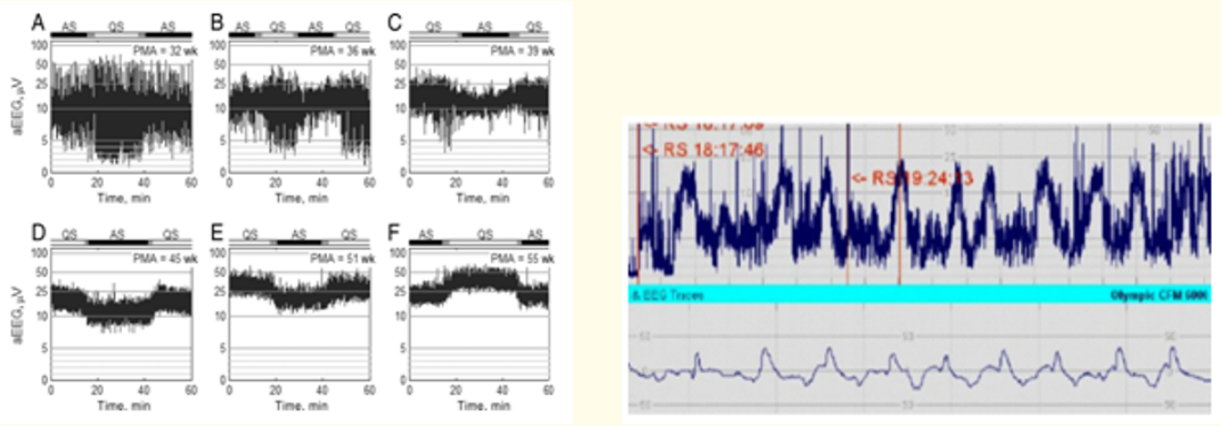

Figure 1: *(A) Tracing types as classified by Al Naqeeb. (B) convulsive tracing [2,3].*

Tracing type	Frequencies	Percentage
Type I	48	49
Type II	22	22,4
Type III	28	28,6
Total	98	100,0

Table 1: *Repartition of aEEG classification according to Al Naqeeb.*

The software used for the study of the results was SPSS version 16.0. The prognostic value of aEEG was tested by the chi-square test based on their becoming at the end of hospitalization. A $p < 0.05$ was considered significant.

Results

40 of the 48 babies with type I tracing had a favorable outcome, while 25 of the 50 who have moderately to severely pathological tracings died or developed neurological sequelae. The aEEG therefore has a predictive value in newborns with a sensitivity of 75%, specificity of 61%, positive predictive value of 50% and a negative predictive value of 83%. A suspected clinical seizure was confirmed in 57 among 66 newborns. The detection of subclinical seizures was possible in 12 newborns.

In our unit; we use the phenobarbital for seizures in the first time, after that if we need intubation, the treatment is sedation with midazolam. Therapeutic hypothermia was used in Hypoxic-ischemic encephalopathy classified Sarnat II or I and in term newborns.

In terms of treatment, aEEG has shown the efficacy of phenobarbital-based monotherapy showing a loss of electrical seizures in 60 among 69 newborns. While 9 others need a secondary bi-therapy, based on midazolam and phenobarbital in 7 cases and on phenobarbital and valproate in 2, to make crises disappear. Furthermore, using the aEEG as a selection criterion, 8 newborns have been selected for the establishment of hypothermia then have been monitored.

Discussion

The aEEG is a technique for monitoring cerebral function established in 1960. It has been defined by Maynard in 1979 as a machine designed to "monitor" the EEG tracing for long periods ranging from hours to days. It records and produces the revised graphical EEG on

paper with slow scrolling signal, in parallel, continuous measurement of the impedance of the electrode [4]. The aEEG outcome essential and neonatal and pediatric intensive care in various situations such as screening seizures, monitoring of antiepileptic therapy, and establishment of neurological prognosis (anoxo-ischemia).

Several studies have shown that aEEG is very accurate for predicting the become in terms of asphyxia in newborns especially when performed early [2,5-7].

Study	Year	Predictive value of the become	Time
L Hellström-Westas [5]	1995	91,5%	≤ 6H
Al Naqeeb., et al. [2]	1999	77 - 90%	≤12H
Toet Mc., et al. [6]	1999	86 - 91%	6H
L Hellström-Westas et I. Rosen [7]	2006	80 - 90%	3 - 6H
Our study	2013	50 - 83%	No time

Table 2: *Table comparing the predictive values of the study and aEEG.*

The establishment of prognostic within the anoxo-ischemia of the term newborn must also take into account the presence of modulation indicating a sleep-wake activity. In children in encephalopathy, there is a noticeable difference in the sleep-wake cycles according to their severity. Time to beginning, increasing the duration of active sleep and also the quality of sleep-wake cycles can all allow prognostic assessment in these cases. Thus, within 36 hours of onset of sleep-wake cycles, increased active sleep duration are predictive of a favorable become among newborns [8]. The aEEG is currently regarded by some teams as a method of choice to determine, before six hours of life, what are the newborns who may benefit from early prophylactic treatment after perinatal asphyxia. This assessment, based on the degree of inactivity, must nevertheless be confronted with the well-established notion of inactive tracing early followed by rapid recovery. The positive and negative predictive values are slightly lower for recordings made at three rather than six hours of life but are considered enough to justify the use of the technique of hypothermia in these indications. It also keeps a great interest in exploring the seizures that occur in the newborn by a sharp increase in the basic activity. It allows to verify the clinical suspicion of seizures, with a very good sensitivity for long-term seizures and epileptic status like those of up to 100% [9]. By its continuous setting, this monitoring helps identify more crises than clinical monitoring and traditional discontinuous EEG, including subclinical seizures. The use of multiple leads, rather than one, also improves the detection [10]. Comparisons made between the information provided by the aEEG and conventional EEG [11] confirms that aEEG is a reliable tool for monitoring the basic activity and critical activity. It can also be helpful in the monitoring of anticonvulsant treatment [7] showing the persistence or not of electrical activity after initiation of treatment. In preterm newborns, the aEEG is also feasible for the monitoring of brain function. But unlike tracings in term newborns, preterm ones are less characteristics. However, it assesses of brain maturation, showing an increase of the amplitude of the upper and lower margins with gestational age (GA) and postmenstrual age (PMA) (Figure 2). This has enabled some teams to establish reference values [12,13] (Figure 3).

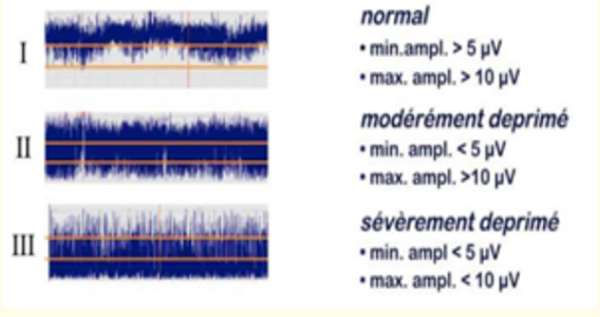

Figure 2: *Evolution of tracings according to the post menstrual age (PMA) [12].*

GA or PCA (wk)	Dominating Background Pattern	SWC	Minimum Amplitude (mcV)	Maximum Amplitude (mcV)	Burst/h
24 through 25	DC	(+)	2 to 5	25 to 50 (to 100)	>100
26 through 27	DC	(+)	2 to 5	25 to 50 (to 100)	>100
28 through 29	DC/(C)	(+)/+	2 to 5	25 to 30	>100
30 through 31	C/(DC)	+	2 to 6	20 to 30	>100
32 through 33	C/DC in QS	+	2 to 6	20 to 30	>100
34 through 35	C/DC in QS	+	3 to 7	15 to 25	>100
36 through 37	C/DC in QS	+	4 to 8	17 to 35	>100
38+	C/DC in QS	+	7 to 8	15 to 25	>100

Modified data from references 2, 4, 13-18, 42, 43. Sleep-wake cycling: SWC (+)=imminent, immature; SWC +=developed SWC; QS=quiet/deep sleep; DC=discontinuous background pattern, (C)=continuous

Figure 2: *Reference values of the amplitudes of EEG according to age [13].*

Data concerning the prognosis value of the aEEG in preterm newborns are rare. The few studies which have been conducted as part of the intraventricular hemorrhage (IVH), found that the severity of aEEG tracings was based on the severity of the IVH and thereby determining the long term become.

A continuous background track, a high frequency of 'burst', as well as the presence of sleep-wake cycles are indicators of a good long-term outcome.

In addition, seizures are also detectable in premature as in term newborns by aEEG. Their presence is predictive of a poor prognosis [14]. Regarding the treatment administered, the studies done have shown a more or less severe depressive effect of some drugs, such as, midazolam, phenobarbital, surfactant and morphine on background electrocortical activity. Some drugs have also shown effects on burst tracings by decreasing their numbers and expanding inter-burst intervals [15]. The aEEG monitoring is a complementary technique of standard electroencephalogram (EEGs). It offers several advantages like its availability at any time, it's easy setting, accessibility and possibility of long course records.

However, some limitations should be noticed [3]: it does not give information on the physiological figures and focal acute elements such as EEGs. It mainly provides information on the amplitude, continuity, inter-hemispheric synchrony and sleep stages; the reduced number of the electrodes may cause an underestimation of convulsions, when they occur in areas away from the electrodes. Artifacts produced by patient movement, the high frequency oscillatory ventilation and electrodes indecisive limit the interpretation of tracks [7] by creating a false elevation of the background activity. However, sedation, cerebral edema and reduced electrode distance can reduce the electrical activity of substance. To overcome both limitations and optimize its operation, it is necessary to train and motivate medical and paramedical staff on several points: The stable and precise positioning of the electrodes, the impedance monitoring, on-screen markers at care, the movements of the child, and crying.

For reliable interpretation, it should also take into account special situations often encountered: prematurity and administration of certain treatments. Wherever possible, a comparison of the results os an aEEG to standard EEG also will minimize the risk of error.

MRI and SpectroMRI allow us to evaluate the early and late effects of hypoxic ischemia on brain structures and metabolism. On the spin echosequences, signal abnormalities are observed in the deep cortical grey matter and correspond to edema. The distribution of affected areas is dependent on the stage of active myelination. For instance, in full-term infants, MRI may show an impairment of the cerebral cortex which is an area of active myelination. These lesions are not seen in preterm children. More recently, diffusion imaging has been used to study acute ischemic lesions [16].

Conclusion

The aEEG is an affordable and simple monitoring technique to use that has continued over the years to show his growing interest in neurology and in intensive care units. Since its establishment, several studies have examined his contribution in neonatology. Our study is therefore to confirm its contribution in diagnosis, treatment and prognosis in various situations both in at term and preterm newborns. It is indicated in many situations, the most common are anoxo-ischiemia of the newborn and neonatal convulsions. Some limitations were noted, but despite all, aEEG remains an examination of choice especially in the neurological emergency situations where early assessment is necessary for the therapeutic decision. Despite this undeniable contribution, the aEEG does not substitute in any case the standard EEG which remains the investigation of choice

Competing Interests

The authors declare no competing interest.

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