RELATION BETWEEN ELECTROGRAPHIC SEIZURES DETECTED BY AMPLITUDE-INTEGRATED EEG AND SHORT-TERM OUTCOMES AFTER TRAUMATIC BRAIN INJURY IN CHILDREN

By

Abd El-Sattar Abdullah El-Sayeh*, Ahmed Mohammed Ahmed Dawood*, Ahmed Yousef Al-Sawah*, Sahar Mohamed Ahmed Hassanein**

Pediatric Departments, Faculty of Medicine, Al-Azhar* and Ain Shams** universities, Cairo, Egypt

ABSTRACT

Background: *Traumatic brain injury (TBI) is a major cause of morbidity and mortality in children. After TBI, the brain is vulnerable to additional injuries (secondary injuries) because injury disrupts normal autoregulatory defense mechanisms. These secondary injuries play a crucial role in patient prognosis. Posttraumatic seizures are an important cause of secondary injuries leading to further damage to the injured brain. Continuous monitoring by electroencephalography (EEG) can detect both clinical and subclinical seizure. This will lead to early treatment of seizures and prevention of further brain damage.*

Objective: *To assess the value of early detection of electrographic seizures by Amplitude-Integrated EEG (aEEG) in relation to short-term outcomes after TBI in children.*

Methods: *This prospective study included thirty-two consecutive, nonrandomized patients with moderate and severe TBI were monitored with aEEG. Clinical and subclinical seizures were assessed for their relation to short-term outcome measures. Outcome measures included hospital stay and KOSCHI score (The King's Outcome Scale for Childhood Head Injury).*

Results: *The main etiology of TBI was falling from height (62.5%), clinical seizures were observed in 43.7%, and subclinical seizures were detected by aEEG in 17 patients (53.1%). The mean days of hospital stay was 6.0 ± 4.0 of which 5.0 ± 3.0 days were in PICU. The median time from TBI onset to aEEG recording was 12 hours and the median duration of aEEG was 18 hours. The main CT findings were diffuse axonal injury, skull fracture, and subdural hematoma. One patient died (3.1%). Those with subclinical seizures significantly had more severe TBI, longer duration on mechanical ventilation and longer hospital stay. Their main CT findings was diffuse axonal injury and had KOSCHI score significantly lower than those without subclinical seizures. Patients with continuous normal voltage (CNV) on initial aEEG have good outcome, while those with burst suppression (BS) and flat trace (FT) have poor outcome.*

According to KOSCHI score, good outcome was significantly achieved in those without subclinical seizures compared to the other group (60 vs 29.4%, p=0.037).

Conclusions: *aEEG background patterns in acute stage after TBI (within the first 24 hrs.) can predict both good and poor outcomes in these patients. A favorable aEEG pattern (CNV) is a good indicator of a good outcome while unfavorable aEEG patterns (BS and FT) are associated with a poor outcome. Posttraumatic subclinical seizures were related to poor neurological outcomes.*

Key words: *Amplitude-Integrated EEG, traumatic brain injury, subclinical seizures.*

INTRODUCTION

Critical care of traumatic brain injury (TBI) in pediatric patients has been subjected to significant development in the past few years that allowed much better survival and recovery **(Luaute et al., 2010)**.

The outcome of such patients varies from total recovery to vegetative state or brainstem affection and death **(Pignat et al., 2016)**.

Prediction of the outcome of pediatric TBI depends on many factors. The severity of primary brain injury and the occurrence of secondary insults are very important factors .Clinical condition and Glasgow Coma Scale (GCS) at admission and King's Outcome Scale for Childhood Head Injury (KOCHI) score-used in our study- are clinical predictors for the outcome of head injury patients. KOSCHI score is a practical outcome scale for pediatric TBI **(Wendong et al., 2018)**.

The KOSCHI was created by Crouchman and colleagues, 2001, due to the lack of evaluation of active and rehabilitation therapies after TBI. It is an adaptation of the original GOS for adults. The 5 categories of the KOSCHI will be mentioned in details in methods. EEG has been used widely for detection of posttraumatic seizure (PTS) in pediatric TBI patients **(Jarin and Karin, 2016)**. The use of EEG for prediction of the outcome of TBI patients is recommended but carries many application difficulties related to equipment and trained physicians **(Rundgren et al., 2006)**. Therefore, a simpler and more convenient method of prediction is needed **(Rosen, 2006)**.

The aEEG is a bedside brain monitoring tool that has gained widespread agreement around the world. aEEG uses a fewer number of channels to record raw EEG signal that is then filtered, rectified, processed, and displayed on a semilogarithmic amplitude and time-compressed scaled,

providing an overview of trends in cerebral background activity and the occurrence of seizures **(Hannah et al., 2014)**.

Continuous aEEG monitoring offers a possibility for direct monitoring of the functional state of the brain over hours and days **(Chen et al., 2014)**. In the present study we aimed to determine the prognostic value of aEEG for short term outcome after acute TBI in children.

PATIENTS AND MATERIALS

Study design:

This prospective study was conducted in Pediatric Intensive Care Unit (PICU), of Al-Hussein University Hospital, Cairo, Egypt during the period from February 2020 to January 2021.

Ethical consideration:

1. Approval of ethical committee, Faculty of Medicine Al-Azhar University.
2. Written consents from parents of the patients.
3. The patients have the right to withdraw from the study at any time.
4. All the obtained data are confidential, and the patients have the right to keep them.
5. The authors declare that there is no any financial support regarding the research and publication.
6. No conflict of interest regarding the study and publication.

Inclusion criteria:

Thirty-four consecutive, nonrandomized acute TBI patients with:

1. Age from 2 to 12 years and both genders.
2. Moderate and severe TBI (classification based on Glasgow coma scale modified for children).
3. Both accidental and no accidental traumas.

Exclusion criteria:

1. Age less than 2 years.
2. Patients with mild TBI.
3. Patients with cerebral palsy and neuromuscular disorders.
4. Patients who acquire chest or GIT infection during hospitalization that affected the hospital stay.

Methods:

All patients were subjected to the following:

1. History taking with stress on: time of injury, seizures, sensorium and symptoms of cranial nerve affection.

2. Complete clinical examination with stress on conscious level using the GCS, modified for children, signs of lateralization, bleeding from orifices, pupil examination and systemic examination for any injury elsewhere (chest, heart, abdomen and back). Injury severity was defined using the modified GCS for children (Teasdale and Jennett, 1974) as follows;
   a. **Mild TBI:** GCS 13–15
   b. **Moderate TBI:** GCS 9–12; Subjects with mild TBI and intracranial abnormalities on CT brain were classified as moderate TBI; this is because GCS is only a one factor in characterizing TBI severity, and underlying intracranial pathologies as detected by CT may be more valuable in predicting long-term sequelae. **(Saatman et al., 2008)** These intracranial abnormalities include contusions, hematomas, and edema with exclusion of isolated nondisplaced linear skull fractures.
   c. **Severe TBI:** GCS3–8.
3. Patient management was done according to our PICU standards of care.
4. Continuous aEEG monitoring was initiated after patient stabilization. aEEG readings were reported and interpreted by pediatric neurologist. aEEG tracings were assessed for background pattern and seizures. Patients were monitored for minimum 24 hours unless clinical condition necessitated shorter (as death or hospital discharge) or longer (as in ongoing seizures) period. The aEEG was recorded as a two channel EEG using gold caps electrode with BRM2 and BRM3 monitors (Neuron-spectrum-1digital neurophysiologicals system, Russia). Electrodes were placed on the scalp corresponding to the positions C3, P3, C4, and P4 of the international 10–20 system. A reference electrode was placed on the patients' forehead.

Background Patterns:

Background patterns were classified into continuous normal voltage (CNV), discontinuous normal voltage (DCV), continuous low voltage (CLV), burst suppression (BS), and flat trace (FT) **(Hellström-Westas and Rosén, 2006)**. CNV was considered as a normal background pattern, whereas all other background patterns were considered abnormal.

Electrographic or subclinical seizures:

Electrographic seizures were identified by an abrupt rise in the minimum amplitude (and the maximum amplitude). They were confirmed by examining the raw EEG for simultaneous seizure activity for at least 10 seconds (sharp waves, spikes, spike-slow wave). According to their frequency of appearance we classified them as single seizure, repetitive seizures (3 or more seizures within the tracing), and electrical status (ES) (continuous seizure activity for more than 5min). According to these electrographic or subclinical seizures, patients were classified into group A (those with subclinical seizures) and group B (those without subclinical seizures)

5. Short term Outcome (at hospital discharge) was measured by: hospital stay and KOSCHI score. KOSCHI score is a practical outcome scale for pediatric TBI. The KOSCHI score (Crouchman et al., 2001) is an adaptation of the original GOS for adults. The 5 categories of the KOSCHI include:

KOSCHI category	Definitions
Death	
Vegetative	The child is breathing spontaneously and may have sleep/wake cycles. He may have non-purposeful or reflex movements of limbs or eyes. There is no evidence of ability to communicate verbally or non-verbally or to respond to commands.
Severe disability	a) The child is at least intermittently able to move part of the body/eyes to command or make purposeful spontaneous movements; for example, confused child pulling at nasogastric tube, lashing out at carers, rolling over in bed. May be fully conscious and able to communicate but not yet able to carry out any self-care activities such as feeding. b) b) Implies a continuing high level of dependency, but the child can assist in daily activities; for example, can feed self or walk with assistance or help to place items of clothing. Such a child is fully conscious but may still have a degree of post-traumatic amnesia.
Moderate disability	a) The child is mostly independent but needs a degree of supervision/actual help for physical or behavioral problems. Such a child has overt problems; for example, 12 year old with moderate hemiplegia and dyspraxia insecure on stairs or needing help with dressing. b) b) The child is age appropriately independent but has residual problems with learning/behavior or neurological sequelae affecting function. He probably should have special needs assistance but his special needs may not have been recognized/met. Children with symptoms of post-traumatic stress are likely to fall into this category.
Good recovery	a) This should only be assigned if the head injury has resulted in a new condition which does not interfere with the child's well-being and/or functioning; for example: • Minor headaches not interfering with social or school functioning • Abnormalities on brain scan without any detectable new problem • Prophylactic anticonvulsants in the absence of clinical seizures • Unsightly scarring of face/head likely to need cosmetic surgery at some stage • Mild neurological asymmetry but no evidence of effect on function of limb. Includes isolated change in hand dominance in young child. b) Implies that the information available is that the child has made a complete recovery with no detectable sequelae from the head injury.

Statistical analysis:

Our results were statistically analyzed by using the SPSS computer package version 25.0 (IBM SPSS Statistics for Windows, Armonk, NY: IBM Corp., USA). The mean ± SD or median (minimum, maximum) were used for quantitative variables as appropriate while number and percent were used for qualitative variables. In order to assess the differences in frequency of qualitative variables, Chi-square or Fisher's exact tests were applied. In order to assess the differences in means of quantitative variables, Mann-Whitney U-test was used for non-parametric statistics. The statistical methods were verified, assuming a significant level of $p < 0.05$. Regarding the interpretation of aEEG, the predominant background pattern and the predominant seizure classification were used for statistical analysis.

RESULTS

Our result will be demonstrated in the following tables and figures

Table (1): General characteristics of the studied patients

Variables		No.=32 (%)
Age (years)	Mean ± SD (Min – Max)	5.0 ± 0.67 (2.0 – 9.0)
Sex	Male	18 (56.25)
	Female	14 (43.75)
Severity of TBI	Moderate	20 (62.25)
	Severe	12 (37.75)
Etiology of TBI	Road traffic accident	10 (31.25)
	Falling from height	20 (62.5)
	Non-accidental	2 (6.25)
Clinical seizures (Total=14)	Moderate TBI	5 (15.6)
	Severe TBI	9 (28.1)
Subclinical seizures		17 (53.1)
Combined clinical and subclinical seizure*		8 (25.0)
Hospital stay (days) Mean ± SD (Min – Max)	PICU stay	5.0 ± 3.0 (3 – 8)
	Whole hospital stay	6.0 ± 4.0 (3 – 10)
Time from TBI onset to aEEG recording (hr)	Median (Min–Max)	12 (8 – 24)
Duration of aEEG (hr)	Median (Min–Max)	18 (12 – 30)
CT findings	Subdural hematoma	5 (15.6)
	Epidural hematoma	3 (9.4)
	Subarachnoid hemorrhage	2 (6.25)
	Diffuse axonal injury	9 (28.1)
	Skull fracture	7 (21.9)
	Intracerebral hemorrhage	3 (9.4)
	Multiple findings	3 (9.4)
Deaths		1 (3.1)

*means that both clinical and subclinical seizures occurred in the same patients

This table describe the general characteristics of our patients, their mean age was 4.0 ± 0.67 years ranged from 2 to 9 years, 56.25% were males, more than one third (37.75%) had severe TBI, and the main etiology of TBI was falling from height (62.5%) then road traffic accident (31.25%). Clinical seizures were observed in 14 out of 32 patients (43.7%) of which 5 moderate had and 9 had severe TBI, subclinical seizures were detected in 17 patients while both clinical and subclinical

seizures were recorded in 8 patients (25%). The mean days of whole hospital stay was 6.0 ± 4.0 ranged from 3 – 10 days of which 5.0 ± 3.0 days were the mean PICU stay. The median time from TBI onset to aEEG recording was 12 hours and the median duration of aEEG was 18 hours. The main CT findings were diffuse axonal injury, skull fracture, and subdural hematoma (28.1%, 21.9%, and 15.6% respectively). Death occurred in one cases (3.1%).

Table (2): Amplitude Integrated electroencephalography results in group A and group B and outcomes

Variables		Group A (with subclinical seizures) No.= 17	Group B (without subclinical seizures) No.= 15	P-value
Initial aEEG	CNV	6 (35.3)	9 (6.0)	0.300
	DNV	7 (41.2)	4 (26.67)	0.729
	CLV	2 (11.76)	2 (13.3)	1.000
	BS	1 (5.88)	0 (0.0)	1.000
	FT	1 (5.88)	0 (0.0)	1.000
Clinical seizures		8 (47.0)	6 (40.0)	0.510
Severity of TBI	Moderate	8 (47.0)	12 (80.0)	0.039*
	Severe	9 (53.0)	3 (20.0)	
Hospital stay (days)		8.0 ± 4.3	4.0 ± 3.1	0.004*
Duration on mechanical ventilation in severe TBI (days)		3.0 ± 1.5	2.0 ± 0.5	0.016*
CT findings	Subdural hematoma	0 (0.0)	5 (33.3)	0.016*
	Epidural hematoma	1 (5.9)	2 (13.3)	0.591
	Subarachnoid Hge	1 (5.9)	1 (6.66)	1.000
	Diffuse axonal injury	9 (53.0)	0 (0.0)	0.001*
	Skull fracture	0 (0.0)	7 (46.7)	0.002*
	Intracerebral Hge	2 (11.76)	1 (6.66)	0.604
	Multiple findings	3 (17.65)	0 (0.0)	0.105
KOSCHI score		3.0 ± 1.3	4.0 ± 0.7	0.010*
Patients received anti-seizure drugs[1]		17 (100.0)	8 (53.3)	0.001*
Number of anti-seizure drugs	Single	4 (23.5)	6 (75.0)	0.038*
	Multiple	13 (76.5)	2 (25.0)	

CNV: continuous normal voltage, DNV: discontinuous normal voltage, CLV: continuous low voltage, BS: burst suppression, FT: flat trace, SE: status epilepticus. Hge: hemorrhage
Values present as mean ± SD were analyzed by Mann-Whitney U-test.
Values present as number & percent were analyzed by Fisher's exact test.
1: In group B, only 8 patients (53.3%) received anti-seizure drugs, *: Significant.

This table compares those with and without subclinical seizures; no significant differences were observed regarding initial aEEG recording and number of clinical seizures, while severity of TBI was significantly evident among those with subclinical seizures with significantly longer days on mechanical ventilation and longer hospital stay. When comparing the CT findings, both skull fracture and subdural hematoma were reported in those without subclinical seizures while diffuse axonal injury was significantly noticed in 53% of those with subclinical seizures. KOSCHI score was significantly lower among those with subclinical seizures (P=0.010). Significantly, all patients with subclinical seizures received anti-seizure drugs (P=0.001) with multiple medications (P=0.038).

Table (3): Distribution of outcomes among different initial aEEG background

Initial aEEG	Total No.	Good No. (%)	Moderate outcome No. (%)	Poor outcome No. (%)
CNV	15	10 (66.7)	3 (20.0)	2 (13.3)
DNV	11	4 (36.4)	6 (54.6)	1 (9.0)
CLV	4	1 (25.0)	2 (50.0)	1 (25.0)
BS	1	0 (0.0)	0 (0.0)	1 (100.0)
FT	1	0 (0.0)	0 (0.0)	1 (100.0)

CNV: continuous normal voltage, DNV: discontinuous normal voltage, CLV: continuous low voltage, BS: burst suppression, FT: flat trace.

The outcome after initial aEEG recording, according to the results of KOSCHI score, was variable. Good outcome was recorded in 10 out of 15 (66.7%) in CNV and in 4 out of 12 (36.4%) in DNV. Moderate outcome was obvious in 2 out of 4 (50.0%) in CLV while it was poor for both BS and FT.

Table (4): Classification of outcome according to KOSCHI score

Outcome	KOSCHI category	KOSCHI subcategory	No. =32 (%)
Poor	Death	-	1(3.1)
	Vegetative	-	0 (0.0)
	Severe disability	3a	3 (9.4)
		3b	4 (12.5)
Moderate	Moderate disability	4a	3 (9.4)
		4b	7 (21.9)
Good	Good recovery	5a	5 (15.6)
		5b	9 (28.1)

According to categories and subcategories of KOSCHI score, good recovery occurred in 9 patients (28.1%) among subcategory 5b and 5 patients (15.6%) among subcategory 5a and moderate disability was noticed in 7 patients (21.9%) among subcategory 4b and 3 patients (9.4%) among subcategory 4a. Poor outcome with severe disability was observed in 4 patients (12.5%) among subcategory 3b and 3 patients (9.4%) among subcategory 3a while death occurred in one patient (3.1%) with no vegetative category recorded.

Table (5): Distribution of outcomes among both groups by KOSCHI score

Outcome	Group A No.= 17 (%)	Group B No.= 15 (%)	P-value
Good	5 (29.4)	9 (60.0)	0.037*
Moderate	4 (23.6)	5 (33.3)	
Poor	8 (47.0)	1 (6.66)	

Values present as number & percent were analyzed by Chi-square test.
*: Significant.

According to KOSCHI score, good outcome was significantly achieved in more than half of patients in group B compared to 29.4% in group A, moderate outcomes were relatively similar in both groups while poor results were the significant outcome in 47% of patients in group A compared to 6.66% in group B.

DISCUSSION

The study included 32 children fulfilling inclusion criteria with moderate to severe acute TBI requiring PICU admission during the period from February 2020 to January 2021.

TBI in children has significant effect on their neurological function and posttraumatic seizures (PTS) are an important cause of secondary injuries causing further brain damage. So, our study was designed to assess the relationship between aEEG findings in pediatric TBI and short-term outcomes and its value in detection of PTS for early treatment which could affect patient prognosis.

The main etiology of TBI in our study was falling from height (62.5%) then road traffic accident (31.25%) while the least cause was nonaccidental trauma (NAT). This was inconsistent to the study of **Vaewpanich and Reuter-Rice, 2016**, in which NAT was the main etiology which could be explained by the difference in culture in our country.

The main CT findings were diffuse axonal injury, skull fracture, and subdural hematoma. Similar results were reported by **Vaewpanich and Reuter-Rice, 2016**. Our study demonstrated that a favorable aEEG pattern (CNV) was associated with a good outcome in 66.7%. An unfavorable aEEG pattern (CLV, BS, or FT) was indicative of a poor outcome. The intermediate pattern (DNV) showed either good or poor outcomes.

Our findings are largely consistent with **You et al, 2018**, who evaluated the prognostic value of aEEG in patients with coma after acute brain injury. They demonstrated that a favorable aEEG pattern (CNV) was associated with a good 6-month neurological outcome with a sensitivity of 93.6% and specificity of 85.2%. An unfavorable aEEG pattern (CLV, BS, or FT) was indicative of a poor neurological outcome after 6 months with sensitivity and specificity of 76.5% and 100%. However, the intermediate pattern (DNV) showed limited predictive value for both good and poor outcomes.

Also, our results are largely matching with previous reports that aEEG background patterns correlate with the neurological outcomes of adult comatosed patients after cardiac arrest treated with hypothermia **(Rundgren et al., 2006**, **Rundgren et al., 2010**, **Oh et al., 2013**, **Oh et al., 2015** and **Sugiyama et al., 2016)**.

Ramachandrannair et al, 2005, found that a reactive encephalographic pattern could determine neurological outcome and mortality in both adult and pediatric TBI patient, and a nonreactive EEG pattern was associated with poor neurological outcome. **Hofmeijer et al, 2014**, reported in their study that BS was associated with poor neurological outcomes in anoxic brain injury and pediatric TBI patients.

The timing and duration of aEEG differ in different studies and most studies start aEEG late after the onset of TBI. In our study, the median time from TBI onset to aEEG recording was 12 hours and the median duration of aEEG was 18 hours. So, started early and our recording lasts longer. **You et al, 2014**, in their study started aEEG monitoring 7 days after coma onset at a median of 7.5 days (7–14) with duration of 8.5 hours (median of 6–12 hrs.). This is because most of their patients underwent cranial surgery which is not the case in our study.

The optimal timing of aEEG monitoring to achieve the greatest prognostic value is a major concern in studies of this type. In previous studies, aEEG was recorded upon arrival at the PICU and usually lasted for 72 hours which is largely consistent with our study **(Rundgren et al., 2006)**.

The number of electrodes or channels of aEEG is another point of debate. Single-channel or two channels are the most commonly reported in the literature **(Tjepkema et al., 2017)**. In our patients we used a two channels EEG. This is more applicable and feasible in PICU patients, but the problem is that localized EEG abnormalities could be missed **(Rundgren et al., 2006)**.

Subclinical seizures were detected by aEEG in 17 patients (53.1%), of which 8 patients had also clinical seizures either by history or on presentation. Therefore, clinical observation of seizures alone in patients after TBI is not enough to rule out seizure activity. You et al, 2018, identified a less number in their cohort (9 patients, 7.0%) and didn't report status epilepticus. The difference may be due to the longer time from TBI onset to aEEG recording and the early seizure prophylaxis in their study. Also, **Vaewpanich and Reuter-Ric, 2016**, reported subclinical seizures only in 1.25% of their patients. This is also could be due to late onset of EEG recording (1.42 ± 0.9 days) and the small sample in their study (16 patients only).

The prevalence rates of subclinical seizures in PICU patients detected by continuous EEG monitoring vary between 7% and 39%. **(Jette et al., 2006**, **Saengpattrachai et al., 2006**, **Shahwan et al., 2010**, **Abend et al., 2011**, **Hahn, 2011** and **Williams et al., 2011)**.

Most of the studies had few TBI patients, some included other etiologies for coma than TBI, were retrospective and initiation of the EEG was started after the first 24 hours of TBI, which may a source of bias. Our study is prospective using aEEG for all consecutive, nonrandomized, moderate, and severe TBI patients admitted to the PICU.

In our study subclinical seizures were reported within the first 24 hours after admission. So, when aEEG monitoring started later than the 24 hours subclinical seizures will be missed. The initiation of continuous EEG monitoring within the first 24 hours after TBI is consistent with the American Clinical Neurophysiology Society's recommendation **(Herman et al., 2015)**.

When comparing those with and without subclinical seizures, no significant differences were observed regarding initial aEEG recording and number of clinical seizures, while severity of TBI was significantly evident among those with subclinical seizures with significantly longer days on mechanical ventilation and longer hospital stay. KOSCHI score was significantly lower among those with subclinical seizures. Significantly, all patients with subclinical seizures received anti-seizure drugs with multiple medications.

Our results are in consistent with the results of **Arndt et al, 2013**, who found that subclinical seizures or status epilepticus were significantly associated with worse outcomes as measured by KOSCHI and hospital length of stay. Similar finding was reported by **Claassen et al, 2006**.

These finding are largely in accordance with **Vaewpanich and Reuter-Rice, 2016** who reported that seizures detected by continuous EEG monitoring in pediatric patients with moderate to severe TBI were associated with poor outcomes, but they used scores for outcome measure other than KOSCHI which were Glasgow Outcome Scale-Extended, Pediatrics (GOS-E Peds) and Speech Pathology Neurocognitive/Functional Evaluation (SPNFE).

During subclinical seizures physiological and subsequent

anatomical changes could occur. Physiological changes include increases in intracranial pressure and metabolic stress; anatomic changes can include hippocampal atrophy **(Vespa et al., 2010)**.

Intracranial hemorrhage is known to be a risk factor for post-traumatic seizures. A more severe injury (cerebral edema, infarction, and midline shift) was also related to seizures **(Arndt et al., 2013)**.

CONCLUSION

aEEG is useful tool for monitoring pediatric patients with acute TBI. Background patterns on aEEG in acute stage of coma after TBI (within the first 24 hours) can predict both good and poor outcomes in these patients. A favorable aEEG pattern (CNV) is a good indicator of a good outcome while unfavorable aEEG patterns (CLV, BS, and FT) are associated with a poor outcome. Posttraumatic subclinical seizures detected by aEEG were related to poor neurological outcomes.

RECOMMENDATIONS

We recommend early and continuous monitoring of all acute moderate and severe TBI patients with aEEG for detection of subclinical seizures.

Study limitations:

First, it was the small sample size. Second, a two-channel recording can miss localized EEG abnormalities. Third, it was a single center study. A multi-center studies with larger sample sizes are necessary to evaluate the prognostic value of aEEG.

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العلاقة بين النوبات الكهربية التي تم اكتشافها بواسطة تخطيط المخ الكهربائى متكامل السعة والنتائج قصيرة المدى بعد إصابات الدماغ الرضحية عند الأطفال

احمد محمد احمد داود*، عبدالستار عبدالله السايح*، احمد يوسف السواح*، سحر محمد احمد حسنين**

أقسام طب الأطفال، كلية الطب، جامعة الأزهر* وعين شمس**، القاهرة، مصر

المقدمة: إن الإصابات الرضحية في الدماغ (TBI) تعد سببا رئيسيا للمرضية والوفاة عند الأطفال. بعد إصابات الدماغ الرضحية، يصبح الدماغ عرضة لإصابات إضافية (إصابات ثانوية) لأن الإصابة تعطل آليات دفاع التنظيم الذاتي العادية. تلعب الإصابة الثانوية دورًا مهمًا في تشخيص المريض. تعتبر نوبات ما بعد الصدمة سببًا مهمًا للإصابات الثانوية التي تؤدي إلى مزيد من الضرر للدماغ المصاب. يمكن للمراقبة المستمرة عن طريق تخطيط كهربية الدماغ أن تكشف عن النوبات السريرية وتحت الإكلينيكية. سيؤدي هذا إلى العلاج المبكر للنوبات والوقاية من المزيد من تلف الدماغ.

الهدف: تقييم قيمة الاكتشاف المبكر للنوبات الكهربية عن طريق تخطيط أمواج الدماغ المتكامل السعة (aEEG) فيما يتعلق بالنتائج القصيرة بعد إصابات الدماغ الرضحية عند الأطفال.

الطريقـــة: أجريـــت هـــذه الدراســـة الاســـتباقية فـــي وحـــدة العنايـــة المركـــزة للأطفـــال (PICU)، قســـم طـــب الأطفـــال فـــي مستشـــفى الحســـين الجـــامعي، القـــاهرة، مصـــر خـــلال الفتـــرة مـــن فبرايـــر 2020 إلـــى ينـــاير 2021. تـــم إدراج واحـــد وثلاثـــون مريضًـــا متتاليًـــا غيـــر مختـــارين مصـــابين بإصـــابات الـــدماغ الرضـــحية المتوســـطة والشـــديدة. تـــم رصـــدها اســـتباقيا باســـتخدام نوبـــات الصـــرع الســـريرية وتحـــت الإكلينيكيـــة عـــن طريـــق تخطـــيط أمـــواج الـــدماغ المتكامـــل الســـعة (aEEG) وتـــم تقيـــيم علاقتهـــا بمقـــاييس النتـــائج علـــى المـــدى القصـــير. تضـــمنت مقـــاييس النتـــائج الإقامـــة فـــي المستشـــفى ودرجـــة KOSCHI (مقيـــاس نتـــائج الملـــك لإصـــابة الرأس في الطفولة).

النتـــائج: تبـــين فـــي البحـــث أن المســـبب الرئيســـي لإصـــابات الـــدماغ الرضـــحية هـــو الســـقوط مـــن الارتفـــاع (62.5٪). لوحظـــت نوبـــات صـــرعية ســـريرية فـــي 43.7٪، وتـــم الكشـــف عـــن نوبـــات صـــرعية تحـــت الإكلينيكيـــة فـــي 17 مريضـــاً (53.1٪). كـــان متوســـط أيـــام الإقامـــة الكاملـــة فـــي المستشـــفى 6.0 ± 4.0 منهـــا 5.0 ± 3.0 يومًـــا فـــي وحـــدة العنايـــة المركـــزة للأطفـــال. كـــان متوســـط الوقـــت مـــن بدايـــة إصـــابات الـــدماغ الرضـــحية إلـــى تســـجيل aEEG يســـاوى 12ســـاعة ومتوســـط مـــدة aEEG كـــان 18 ســـاعة. كانـــت النتـــائج الرئيســـية للتصـــوير المقطعـــي المحوســـب هـــي إصـــابة محـــور عصـــبي منتشـــر وكســـر فـــي الجمجمـــة ونزيـــف تحـــت الأم الجافيـــة. حـــدثت الوفـــاة فـــي حالـــة واحـــدة (3.1٪)، مجموعـــة الأطفـــال الـــذين يعـــانون مـــن نوبـــات تحـــت الإكلينيكيـــة كانـــت لـــديهم إصـــابات شـــديدة أكثـــر، وأكثـــر مـــن متوســـط الأيـــام علـــى جهـــاز التـــنفس الصـــناعى ومتوســـط أيـــام الإقامـــة

الكاملة في المستشفى. كانت النتيجة الرئيسية للتصوير المقطعي المحوسب هي الإصابة المحورية المنتشرة وكانت درجة KOSCHI (مقياس نتائج الملك لإصابة الرأس في الطفولة) أقل بكثير من تلك التي لم تحدث لهم نوبات تحت الإكلينيكية. تم تسجيل نتيجة جيدة في المرضى الذين سجلت فيهم تخطيطات المخ الأولية جهدا عاديا مستمرا CNV بينما كانت ضعيفة لكل من قمع الانفجار والتتبع المسطح. وفقًا لنتيجة KOSCHI، تم تحقيق نتيجة جيدة بشكل ملحوظ في المجموعة A(60%= في مقابل المجموعة B مقارنة بالمجموعة (29.4%.

الخلاصة: يمكن لأنماط aEEG (تخطيط أمواج الدماغ المتكامل السعة) في المرحلة الحادة من الغيبوبة بعد إصابات الدماغ الرضحية (خلال الـ 24 ساعة الأولى) أن تتنبأ بالنتائج الجيدة والسيئة في هؤلاء المرضى. يعد نمط aEEG المواتي (CNV) مؤشرًا جيدًا على نتيجة جيدة بينما ترتبط أنماط aEEG غير المواتية (CLV و BS و FT) بنتائج سيئة، وكانت النوبات تحت الإكلينيكية بعد الصدمة مرتبطة بنتائج عصبية سيئة.