STUDY OF NORMAL ADULT EEG AND PATTERNS OF UNCERTAIN CLINICAL SIGNIFICANCE

By

**Gamal Ahmed Shawer,*Kamel Mahmoud Hewedi,
Shebl Ramadan Samaha, *Ahmad Frag Ibrahim
and Mahmoud Ahmed Mohamed**

Departments of Clinical Physiology and *Neurology, Al-Azhar Faculty of Medicine

ABSTRACT

Background: Electroencephalogram (EEG) is a mean of investigation of cortical and subcortical brain functional activity. Certain benign patterns may be epileptiform, yet can occur in healthy individuals without clinical epilepsy.

Objective: Study of normal adult EEG and patterns of uncertain clinical significance.

Subjects and Method: The present study was conducted on 100 adult Egyptian subjects (64 males and 36 females). All were subjected to history taking, examination and EEG evaluation.

Results: Fifteen percent of participants have benign variants in their recorded EEG including Mu Rhythm (4%), OIRDA (5%), and FIRDA (6%). OIRDA and Mu Rhythm were more predominant in females, unlike FIRDA which was more predominant in males. The prevalence of artifacts in recorded EEG was 97% among participants. Among participants, there was epileptic activity recorded in 11 % of them. The prevalence of benign variants in EEG in participants was 15 %.

Conclusion: Recording EEG pattern in normal adults help in minimizing over-interpretation and over-treatment of patients.

INTRODUCTION

Electroencephalography (EEG) is a mean of investigation of cortical and subcortical brain functional activity (**Dulac et al., 2013).**

Understanding normal EEG is critical in defining those patterns that are abnormal. EEG is unique in the ability to support a clinical diagnosis of epilepsy as epileptiform patterns merit careful consideration. Certain benign patterns may be epileptiform, yet can occur in healthy individuals without epilepsy. Understanding normal EEG and the benign variants will help to minimize over interpretation and possibly avoid over treatment of patients during routine clinical practice (**William et al., 2010**).

Validation of the signals recorded in EEG is needed before any clinical investigation can be performed. The presence of artifact and normal benign pattern may have major effect on how EEG is evaluated (**Erp et al., 2012**).

The present work was designed to study normal adult EEG and patterns of uncertain clinical significance.

SUBJECTS AND METHODS

The present study was carried out on 100 adult Egyptian subjects (64 males and 36 females). These subjects were relatives of patients, and working staff in Neurology Department, El-Sayed Galal Hospital, with age ranging from 18 – 75 years old, from January 2017 to July 2017.

All subjects gave written consents before sharing in this work.

Inclusion criteria: Normal adults with age ≥ 18 years old.

Exclusion criteria:

1- Epileptic patients.

2- Positive family history of epilepsy.

3- History of febrile seizures.

4- History of significant trauma to the head

5- Subjects taking anti-epileptic drugs.

6- Subjects taking epileptogenic drugs (depolarizing muscle relaxant drugs).

7- History or presence of neurological disorders or systemic diseases that one likely to affect CNS functions e.g. hypo- or hyperthyroidism.

All participants were subjected to:

1- History taking.

2- Thorough general and neurological examinations.

3- EEG was done to all participants while they were awake with eye closed using photic stimulation and hyperventilation in the EEG lab, using 21 electrodes: A neurophysiological assessment was done using conventional EEG. Spontaneous electrophysiological activity was recorded, according to the international 10/20 system for surface electrode placements on an electro-encephalograph (model EEG-4418k, Nihon Kohden corporation. 31-4, Nishiochiai 1-chome shinjukuku, Tokyo 161, Japan) (**Silva, 2005**).

RESULTS

Results of the present work showed that, among the participants, there were: 11% with epileptic activities in their EEG, 15 % have benign variants, and 97% have artifacts (**Table 1**). Benign variants commonly occurred were Mu Rhythm in 4%, occipital intermittent rhythmic delta activity in 5%, and frontal intermittent rhythmic delta activity in 6% (**Table 2**). It was noted that EEG artifacts were more numerous than variants when their were eye blinking in 63%, electrode pope in 65%, pulse artifact in 3%, telephone ring artifact in 3%, power line artifact in 14%, EMG artifact in 30%, VEP in 5%, head movement in 10%, lateral eye movement in 11%, and sweat artifact in 1% (**Table 3**).

Table (1): Number and Percentage of epileptic activity, benign variants and artifacts among the study population (*n* = 100).

Variables	Number	Percentage
Epileptic activity	11	11.0
Benign variants	15	15.0
Artifacts	97	97.0

Table (2): Prevalence of benign variants.

Variables	Number	Percentage
Mu Rhythm	4	4.0
OIRDA	5	5.0
FIRDA	6	6.0

OIRDA: occipital intermittent rhythmic delta activity.
FIRDA: Frontal intermittent rhythmic delta activity.

Table (3): Prevalence of Artifacts.

Variables	Number	Percentage
Eye Blinking or Flutter	63	63
Electrode pope	65	65
Pulse Artifact	3	3
Telephone ring Artifact	3	3
Power Line Artifact	14	14
EMG Artifact	30	30
VEP	5	5
Head Movement	10	10
Lateral Eye Movement	11	11
Sweat Artifact	1	1

VEP: Visual Evoked Potential

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DISCUSSION

Results of the present work showed that 15 % of participants had benign variants in their recorded EEG. These results were in agreement of **Radhakrishnan et al. (2016)** who stated that the prevalence of benign variants in the recorded EEG are 18.3 % and the prevalence rate of benign variants is best determined by ascertaining its occurrence in a normal population. On the other hand, **Tatum et al. (2016)** stated that the prevalence of benign variants in the recorded EEG are less than10 % among normal population and they related their results to the small sample size.

In the present study, the benign variants in recorded EEG were Mu Rhythm (4%), OIRDA (5%), and FIRDA (6%). These results were compatible with **Tatum et al. (2016)** who stated the results of the same variants with nearly the same prevalence. **Radhakrishnan et al. (2016)** stated that the frequency distribution of individual benign variants (BEVs) were as follows: benign sporadic sleep spikes 8.2%, wicket waves 1%, 14 and 6 Hz positive spikes 5.7%, 6 Hz spike-waves 2.8% and rhythmic temporal theta burst of drowsiness 0.8%) and this is due to their very big sample size (2742 individuals) which involved a wide variety of variants.

In the present work, it was found that the prevalence of artifacts in recorded EEG was 97% among normal population. These results were in agreement with **Jose et al. (2015)** who stated that artifacts are undesired signals that cause changes in the measurements and affect the signal of interest. Validation of the signals recorded in EEG is needed before any clinical investigation and the presence of artifact may have major effect on how EEG is evaluated and stated that artifacts were 81% in recorded EEG among normal population and they owed this to bad technician skills, bad preparation of patients and unclear instructions to patients before EEG recording and stated that eye movements, eye blinks, muscle noise, heart signals, and line noise often produce large and distracting artifacts in electroencephalographic EEG recordings.

Jung et al. (2016) stated that artifacts were more than 60 %, and this prevalence in our results can be related to good technician skills, good preparation of patients, and clear instructions to patients before EEG recording and small sample size.

In the present work, artifacts in recorded EEG were eye blinking (63%), electrode pope (65%), pulse artifact (3%), telephone ring artifact (3%), power line artifact (14%), EMG artifact (30%), VEP (5%), head movement artifact (10%), lateral eye movement artifact (11%) and sweat artifact (1%). These results were in agreement with **Jung et al. (2016)** who stated that eye blinking artifacts were 60 %, bad instructions to patients before EEG recording, and inclusion of patients in their sample size are considered in their results and stated that EEG signal is unfortunately often contaminated with various physiological factors other than cerebral activity, which are typically of no interest. They stated that cardiac activity, ocular movements, eye blinks and muscular activity are among the most common kinds of artifacts, and EMG

could often be detected across the entire scalp due to volume conduction of myo-genic activity independently generated by muscles across the head. **Velde et al. (2016)** stated that the high prevalence of EMG artifact is owed to excessive movements of the patients especially the head, and head movements can introduce a wide range of non-cerebral electrical activity into the EEG, typically taking the form of some combination of electrode pope, muscle (EMG), electrode movement and ocular artifacts and these component artifact signals display a wide range of characteristics. Electrode pope, which occurs when an electrode temporarily breaks contact with the surface of the scalp, is usually accompanied by fast, high amplitude spikes. **Jorge et al. (2014)** were with our prevalence as regard head movements and stated that motion sensors of the EEG apparatus are considered a measure to avoid this artifact. **Wallstrom et al. (2015)** were not going with our results as regard prevalence of lateral eye movement artifact and owed this to bad filtering of signals by recording EEG filters.

In the present work, it was noted that there was an epileptic activity in recorded EEG in 11 % of them**. Torkamani et al. (2013)** were in agreement with our results and stated that epileptic activity in recorded EEG occurred in 8 %, and owed this to the narrow sample size, loss of awareness about symptoms of epilepsy, and epileptic activity which is subclinical. So, the patient will be considered to be normal which may predominate as seizures in the future. On the other hand, **Tatum et al. (2016)** are not going with

our results due to their use of a higher sample size, and good awareness about symptoms of epilepsy.

CONCLUSION

Recording EEG pattern in normal adults helps in minimizing over-inter-pretation and over-treatment of patients.

REFERENCES

1. **Delorme, A. and Makeig, S. (2000):** an open source toolbox for analysis of single-trial EEG dynamics including independent component analysis. J. Neurosci. Methods, 134: 9–21

2. **Dulac, O., Lassonde, M. and Sarnat, H. (2013):** Developmental aspects of normal EEG. Handbook of Clinical Neurology, Pediatric Neurology Part. J. of Clinical Neurophysiology, 3: 7-24.

3. **Erp, R. and Barry, R. (2012):** Optimal temperature for selective cerebral perfusion. J. Thorac. Cardiovasc. Surg., 130:74–82.

4. **Jorge, N., Henry, C. and Fessler, A. (2014):** Anti-NMDA receptor encephalitis causing prolonged non-convulsive status epilepticus. Neurology, 75: 1480–2.

5. **Jose, K., Snowdon, D. and Desrosiers, M. (2015):** Early life linguistic ability, late life cognitive function, and neuropathology: findings from the Nun Study. Neurobiol., 26: 341–347.

6. **Jung, A. and Makeig, S. (2016):** EEGLAB: an open source toolbox for analysis of single-trial EEG dynamics including independent compo-nent analysis. Journal of Neuroscience Methods, 134(1): 9-21.

7. **Radhakrishnan, M., Papadelis, C. and Bamidis, P. (2016):** REG-ICA: a new hybrid method for EOG artifact rejection. In: Proceedings of the 9th international conference on information technology and applications in biomedicine. ITAB, 3: 12-24.

8. **Silva, A. (2005):** The functional states of the thalamus and the associated neuronal interplay. Physiological Review, 68: 649–742.

9. **Tatum, W., Dworetzky, B. and Freeman, W. (2016**): Artifact: recording EEG in special care units. J. Clin. Neurophysiol., 28: 264-277.

10. **Torkamani, A., Berkovic, S. and Brodie, M. (2013):** Revised terminology and concepts for organization of seizures and epilepsies: report of the ILAE Commission on Classification and Terminology. Epilepsia, 51: 676–685.

11. **Velde, S., Achanccaray, D. and Vellasco, M. (2016):** Mental Tasks Classification for a Non invasive BCI Application, 19th International Conference on Artificial Neural Networks, ICANN'09, Limassol, Cyprus, 4: 12-65.

12. **Wallstrom, G., Kass, R. and Miller, A. (2015):** Automatic correction of ocular artifacts in the EEG: a comparison of regression-based and component-based methods. Int. J. Psychophysiol., 53: 105–119.

13. **William, M., Merica, H. and Smith, M. (2010**): Beta EEG activity and insomnia. Sleep Med. Rev., 5: 363–374.

دراسة تخطيط الدماغ الكهربي الطبيعي لدى البالغين والأنماط غير محددة المدلول السريرى

جمال أحمد شاور، كامل محمود هويدي*، شبل رمضان سماحة، أحمد فرج إبراهيم*، محمود أحمد محمد

قسمي الفسيولوجيا الطبية والأمراض العصبية*، كلية الطب، جامعة الازهر

خلفية البحث: يعتبر رسم تخطيط الدماغ الكهربي وسيلة لتسجيل النشاط الكهربي للمخ، ويوجد أنماط غير محددة المدلول السريري في الأشخاص الطبيعيين الذين لا يعانون من زيادة في النشاط الكهربي للمخ.

الهدف من البحث: يهدف هذا البحث إلى دراسة تخطيط الدماغ الكهربي الطبيعي وأنماطه غير محددة المدلول السريري لتجنب الخطأ في ترجمة تخطيط الدماغ الكهربي .

الاشخاص وطريقة البحث : تم إجراء هذا البحث على مائة من البالغين المصريين (64 من الذكور و36 من الإناث) وتم اخذ التاريخ المرضي والفحص الإكلينيكى وعمل تخطيط الدماغ الكهربي لهم.

النتائج :خمسة عشر بالمائة من المشاركين لديهم أنماط حميدة في تخطيط الدماغ الكهربي المسجل لهم وتشمل النمط الميو بنسبة 4% والنشاط المتقطع في شكل الموجه دلتا في الفص الخلفي للدماغ بنسبة 5% والنشاط المتقطع في شكل الموجه دلتا في الفص الأمامى للدماغ بنسبة 6%. النشاط المتقطع في شكل الموجه دلتا في الفص الخلفي للدماغ والنمط الميو أكثر إنتشاراً في السيدات علي النقيض النشاط المتقطع في شكل الموجه دلتا في الفص الامامي للدماغ اكثر انتشارا بين الذكور. معدل إنتشار الأخطاء في تخطيط الدماغ الكهربي المسجل بين المشاركين يصل إلى 97%. نسبة النشاط الصرعي في تخطيط الدماغ الكهربي بين المشاركين 11%. معدل إنتشار الأنماط الحميدة في تخطيط الدماغ الكهربي بين المشاركين يصل إلى 15%.

الاستنتاج: قراءة الأنماط غير محددة المدلول السريري في تخطيط الدماغ الكهربي لدي البالغين يساعد علي تقليل الاخطاء الواردة عند ترجمة تخطيط الدماغ الكهربي وكذلك تجنب العلاج غير اللازم لهم.