

The Value of Simultaneous Electrocardiography Recording in the EEG Laboratory

Mahmood Mottamedi,*¹ Fatemeh Najmi-Varzaneh,¹ Farnaz Najmi-Varzaneh,¹ Narges Khansari¹

1. Department of Neurology, Iranian Center of Neurological Research, Tehran University of Medical Sciences, Tehran, Iran

Article information	Abstract
<p>Article history: Received: 20 Nov 2012 Accepted: 26 Dec 2012 Available online: 27 Jan 2013 ZJRMS 2014; 16(6): 36-39</p> <p>Keywords: Epilepsy EEG Cardiac arrhythmia EKG Loss of consciousness</p> <p>*Corresponding author at: Department of Neurology, Iranian Center of Neurological Research, Tehran University of Medical Sciences, Tehran, Iran E-mail: Najmi_f83@yahoo.com</p>	<p>Background: The aim of the current study was to assess the value of simultaneous EKG with EEG to diagnose cardiac disorders in patients with seizure- like attacks and to investigate the extent of misdiagnosis of epilepsy.</p> <p>Materials and Methods: 210 patients presenting with transient loss of consciousness (TLoC) and paroxysmal events suspicious to seizure were studied. All patients had undergone EEG simultaneous with an EKG. Besides reporting the EEG, a cardiologist analyzed the EKG in an attempt to recognize abnormal EKG as a potential cause of TLoC. Moreover, in all patients it was ascertained if any cardiac disorders in patients and their first degree relatives had been diagnosed.</p> <p>Results: Sixteen out of two hundred ten (7.6%) patients had abnormal EKG which was significantly potential cause of symptom of whom 6 patients were found to have bradycardia and 10 patients had dysrhythmias. Moreover, in patients with previous cardiovascular disorder, 30.4% had abnormal EKG where as in patients without cardiac disease only 4.8% had EKG abnormalities. Besides in patients with positive family history for cardiac disease 20.3% had abnormal EKG while in patients without family history of cardiac disease, abnormal EKG was revealed in only 2.05% patients.</p> <p>Conclusion: Simultaneous EKG with EEG is valuable in declining rate of misdiagnosis of epilepsy. Besides, EKG abnormalities in these patients have a significant association with any previous cardiovascular disorders in the patients and in their first degree relatives.</p> <p>Copyright © 2014 Zahedan University of Medical Sciences. All rights reserved.</p>

Introduction

Epilepsy, with a lifetime risk of 3-5%, is one of the most prevalent chronic neurologic disorders [1]. Annual incidence rate of epilepsy is generally accepted around 50 per 100,000 in developed countries and is likely higher in resource- poor countries [2]. Though diagnosis of epilepsy can be straight forward, it sometimes can also be one of the greatest clinical challenges [3]. It has become axiomatic that there is a growing recognition regarding the dilemma of epilepsy misdiagnosis [4]. The misdiagnosis rate of epilepsy has been reported approximately 30% in different studies [5]. One of the utmost condition which masquerade seizure is cardiac arrhythmia [6]. Syncope due to cardiac arrhythmias may be accompanied with seizure like features because of transient cerebral hypoxia [7]. These episodes may be associated with myoclonic jerks, oral automatism, head turning, eyes upward deviation and tonic spasms which are hardly distinguishable from seizures [8, 9]. Some of these cardiac arrhythmic patients which are misdiagnosed as epilepsy, experience long diagnostic delay which could be potentially life-threatening [10-17]. Moreover, as a consequence of incorrect diagnosis, many of these patients are inappropriately treated with anticonvulsant epileptic drugs and also are imposed excessive restrictions on driving and employment which can lead to socio- economic sequels

[18, 19]. In this aspect, previous studies on patients with transient loss of consciousness (TLoC) and seizure-like attacks have shown that simultaneous Electrocardiography (EKG) which are recorded with Electroencephalography (EEG) can disclose many of these cardiac arrhythmias which are potentially as a cause of their symptoms [20, 21]. Therefore, it has been suggested that a simultaneous EKG strip with EEG in patients with TLoC enable the neurologist to recognize most patients with abnormal EKG changes and rhythms and conclusively is worthwhile in diagnosis of cardiac arrhythmic syncope [20]. In addition EKG strip simultaneous with EEG is useful in recognizing EKG artifacts and leads to less often misinterpretation of EKG artifacts as epileptiform discharges [22]. For bolstering the issue, 2011 NICE guidelines have recommended that that all people who have a TLoC episode should have an EKG for preventing misdiagnosis [5]. Since the etiological misinterpretation of paroxysmal neurological symptoms frequently causes a delayed treatment or an inappropriate management which is irreparable and due to lack of enough study in this issue in Iran, the current study designed to discover the prevalence of EKG abnormalities which are potentially capable as a cause of seizure-like attacks and TLoC in patients whom are referred to EEG laboratory and its importance in declining

the misdiagnosis of epilepsy. In addition, past medical history and family history of any cardiovascular diseases has been questioned to ascertain any correlation with EKG abnormality in patients who were formerly diagnosed as seizure.

Materials and Methods

A cross sectional study was exerted for this study. After being approved by Research Ethics Committee of Tehran University of Medical Sciences and proposing a complete explanation about study and taking a written consent from included patients, the individuals enrolled in the study.

Our study included 210 patients selected with simple random sampling method who were suspicious to seizure and presented by 1) TLoC with epileptic attacks, 2) TLoC without epileptic attack and 3) paroxysmal attacks such as recurrent transient events of vertigo, anxiety and paresthesia. The patients were recruited from Neurology clinic of Sina hospital of Tehran University of Medical Science from Jan 2011-Mar 2012. The inclusion criterion were the patients between 15-50 years and history of more than one episode of suspicious attack seizure and the exclusion criteria were patients with central nervous system, metabolic, endocrine or electrolyte abnormalities. The diagnosis of seizure was based on history by an expert neurologist. Simultaneous EKG was performed with EEG in all patients. The equipment used was the electro encephalogram model 9200 manufactured by Nihon Kohden of Portugal. Routine EEG recording was performed in the neurodiagnostic laboratory in a recumbent position. Patients were routinely encouraged to relax during the 30-minute procedure. EKG was recorded with 12 electrodes placed over the routine sites. Seizures were identified by characteristic ictal EEG. EKG strip was considered by a competent nurse and a cardiologist for detecting any significant abnormalities. EEG strip was analyzed by a competent neurologist in an attempt to differentiate normal EEG strip from abnormal. Any previous cardiovascular disease and/or positive family history for cardiovascular disorders in first degree relatives had been diagnosed. The patients who were suspected to pseudo seizure were excluded. Statistical Analysis: Data were analyzed by means of a personal computer implemented with dedicated software (SPSS-19), to obtain Mean \pm SD values, analysis of variance and χ^2 tests, as appropriate. χ^2 and cross-Tab was used for comparison between groups. The level of significance was settled at $< 5\%$, as usual.

Results

Simultaneous EKG with EEG of 210 patients (117 female and 93 male) aged 9-90 with median age of 32.7 year were investigated. Chief complain of 68.8% of patients who were suspicious to seizure was TLoC with epileptic attack, 16.7% was TLoC without epileptic attack and a further 14.5% was paroxysmal attacks suspicious to seizure. 16 out of 210 patients (7.6%) had EKG lead abnormalities.

Among 16 patients, 7 patients (43.75%) had TLoC with epileptic attack, 5 patients (31.25%) had TLoC without epileptic attack and 4 patients (25%) had other paroxysmal events respectively. In patients who had EKG abnormalities, 37.5% were found to have bradycardia and 62.5% had dysrhythmias (arrhythmias and tachyarrhythmia) which were significantly relevant to their symptoms. In one of the patients with complain of loss of consciousness without epileptic attack, just during tracing, it had been developed an attack resembling previous attacks with symptoms including vertigo, sweating and pallor. The patient developed bradycardia; simultaneously with bilateral slow waves in EEG. Furthermore, among the patients with EKG lead abnormality, 62.5% had normal EEG and the rest, 37.5%, had nonspecifically abnormal EEG which couldn't justify the symptoms. Among the patients with previous cardiovascular disorder, 30.4% had abnormal EKG lead while in patients without any previous cardiovascular disorders only 4.8% had EKG abnormalities. The correlation between EKG abnormality and previous cardiovascular disorder was statistically significant ($p < 0.05$). In patients with positive family history for cardiovascular disorder, 20.3% had abnormal EKG while in patients without any family history for cardiovascular disease, EKG lead abnormalities was observed only in 2.05% of patients. The association between EKG abnormality and positive family history in first relative degree was statistically significant ($p < 0.05$).

Discussion

In the current study, approximately 7.5% of patients who were referred due to seizure suspicious had EKG lead abnormalities. The majority of EKG abnormalities were dysrhythmias which could justify their symptoms. In addition the EKG abnormality was more frequent in patients who had a positive family history of cardiac disease. The intricacy in differentiating epilepsy from cardiovascular disorders presenting with paroxysmal events has long been acknowledged [4, 6]. Seizure and cardiogenic syncope share clinical manifestations which are hardly distinguishable. As a consequence, certainty in diagnosis of epilepsy is almost inevitable [7, 23]. Our findings were consistent with a former population based study which has reported that 49 out of 214 patients with a primary diagnosis of epilepsy were ultimately found to have been misdiagnosed and 15 out of 49 misdiagnosed patients (7%) were disclosed to have cardiovascular etiology. The cardiovascular problems in the mentioned study included congenital heart disease, sinuses node disease, postural hypotension and carotid sinus syndrome [24]. However the pure rate of patients with cardiac arrhythmias hasn't been reported. Furthermore, Shott et al. has shown cardiac arrhythmias in 20% of patients who received an initial diagnosis of epilepsy [6]. The higher rate of misdiagnosed patients with cardiac arrhythmia in the mentioned study in comparison to ours seems to be due limited sample size in the above study.

Another study has declared that 31 of 74 (41.8%) patients presented with recurrent seizure-like episodes, had an alternative disorder in whom 2 out of 31 (2.7%) had prolonged bradycardia [4] which was approximately consistent with our results in which 6 out of 210 (2.8%) patients had prolonged bradycardia that justified their symptoms. The problem of misdiagnosis in epilepsy is not limited to adults [25, 26]. In an observational retrospective study on 223 inpatient children referred to neurologic department with epilepsy diagnosis, the diagnosis was disproved in 39% of cases [27], of whom 4 patients (4.5%) had syncope; however, the type of syncope which developed seizure-like attacks in children has not been reported [27].

Pitney et al. have shown cardiac arrhythmia potentially may be cause of loss of consciousness in 17% of patients with TLoC without an established cause and in 5% of patients with TLoC due to epilepsy which was consistent with our findings. Moreover, it has suggested that a simultaneous EKG strip with EEG in patients with transient loss of consciousness enable the neurologist to recognize most patients with abnormal EKG changes and rhythms [20]. The current study in consistent the mentioned studies revealed an alternative diagnosis which was cardiac arrhythmias in 7.6% patients who were referred to EEG lab with probable seizure episodes. Of the utmost findings in our study was the momentous association between EKG lead abnormality and past medical cardiovascular disorders and family history of cardiac disease in which to our knowledge it has not been investigated previously. The most patients, who had been

misdiagnosed, had a positive past history and family history of cardiac disease. Therefore it would be rational that in patients with the risk factor of cardiovascular disease, more investigation be performed. In conclusion, it can be summarized that simultaneous EKG is worthwhile for diagnosis of seizure-like episodes and decline the number of patients who were misdiagnosed as epilepsy and also is important in predicting cardiovascular disorders in patient and first degree relatives. Therefore, it could be recommended to carry out a simultaneous EKG in all patients who have suspected seizure attacks. Hence, on the account of intimate association between unexplained seizure-like attacks and cardiovascular disorders, a mutual approach between neurologist and cardiologists for the suspicious patients is recommended.

Acknowledgment

This article is the result of Mrs. Narges Khansari thesis, number 750 by here we appreciate the participating patients and the members of neurology clinic of Sina hospital in Tehran.

Authors' Contributions

All authors had equal role in design, work, statistical analysis and manuscript writing.

Conflict of Interest

The authors declare no conflict of interest.

Funding/Support

Tehran University of Medical Sciences.

References

- Chang BS, Lowenstein DH. Epilepsy. *N Engl J Med* 2003; 349(13): 1257-66.
- Sander JW. The epidemiology of epilepsy revisited. *Curr Opin Neurol* 2003; 16(2): 165-70.
- Chadwick D, Smith D. The misdiagnosis of epilepsy. *BMJ* 2002; 324(7336): 495-6.
- Zaidi A, Clough P, Cooper P, et al. Misdiagnosis of epilepsy: many seizure-like attacks have a cardiovascular cause. *J Am Coll Cardiol* 2000; 36(1): 181-4.
- Rogers G, O'Flynn N. NICE guideline: transient loss of consciousness (blackouts) in adults and young people. *Br J Gen Pract*. 2011; 61(582): 40-2.
- Schott GD, McLeod AA, Jewitt DE. Cardiac arrhythmias that masquerade as epilepsy. *Br Med J* 1977; 1(6074): 1454-7.
- Britton JW, Benarroch E. Seizures and syncope: Anatomic basis and diagnostic considerations. *Clin Auton Res* 2006; 16(1): 18-28.
- Lempert T, Bauer M, Schmidt D. Syncope: A videometric analysis of 56 episodes of transient cerebral hypoxia. *Ann Neurol* 1994; 36(2): 233-7.
- Bergfeldt L. Differential diagnosis of cardiogenic syncope and seizure disorders. *Heart* 2003; 89(3): 353-8.
- Burghaus L, Liu W, Eggers C, et al. [Mistaking a long QT syndrome for epilepsy: does every seizure call for an ECG?]. *Fortschr Neurol Psychiatr* 2010; 78(7): 419-24.
- Gatto EM, Fernandez Pardal MM, et al. [The long QT syndrome: epilepsy as the form of presentation]. *Rev Clin Esp* 1993; 192(8): 380-2.
- Hunt DP, Tang K, Long QT. Syndrome presenting as epileptic seizures in an adult. *Emerg Med J* 2005; 22(8): 600-1.
- Fitzpatrick AP, Cooper P. Diagnosis and management of patients with blackouts. *Heart* 2006; 92(4): 559-68.
- MacCormick JM, McAlister H, Crawford J, et al. Misdiagnosis of long QT syndrome as epilepsy at first presentation. *Ann Emerg Med* 2009; 54(1): 26-32.
- Omichi C, Momose Y, Kitahara S. Congenital long QT syndrome presenting with a history of epilepsy: Misdiagnosis or relationship between channelopathies of the heart and brain? *Epilepsia* 2010; 51(2): 289-92.
- Sheldon R, Rose S, Ritchie D, et al. Historical criteria that distinguish syncope from seizures. *J Am Coll Cardiol* 2002; 40(1): 142-8.
- Zaidi A, Clough P, Mawer G and Fitzpatrick A. Accurate diagnosis of convulsive syncope: Role of an implantable subcutaneous ECG monitor. *Seizure* 1999; 8(3): 184-6.
- Josephson CB, Rahey S, Sadler RM. Neurocardiogenic syncope: Frequency and consequences of its misdiagnosis as epilepsy. *Can J Neurol Sci* 2007; 34(2): 221-4.
- Smith D, Defalla BA, Chadwick DW. The misdiagnosis of epilepsy and the management of refractory epilepsy in a specialist clinic. *QJM* 1999; 92(1): 15-23.
- Pitney MR, Beran RG, Jones A. A simultaneous electrocardiogram is important when electroencephalography is used in the evaluation of loss of consciousness. *Electroencephalogr Clin Neurophysiol* 1994; 90(3): 246-8.

21. Jacome DE. Temporal lobe syncope: Clinical variants. Clin Electroencephalogr 1989; 20(1): 58-65.
22. Tatum WO, Dworetzky BA, Schomer DL. Artifact and recording concepts in EEG. J Clin Neurophysiol 2011; 28(3): 252-63.
23. Chowdhury FA, Nashef L, Elwes RD. Misdiagnosis in epilepsy: A review and recognition of diagnostic uncertainty. Eur J Neurol 2008; 15(10): 1034-42.
24. Scheepers B, Clough P, Pickles C. The misdiagnosis of epilepsy: Findings of a population study. Seizure 1998; 7(5): 403-6.
25. Akhtar MJ. All seizures are not epilepsy: many have a cardiovascular cause. J Pak Med Assoc 2002; 52(3): 116-20.
26. Mastrangelo M, Mariani R, Ursitti F, et al. Neurocardiogenic syncope and epilepsy in pediatric age: The diagnostic value of electroencephalogram-electrocardiogram holter. Pediatr Emerg Care 2011; 27(1): 36-9.
27. Uldall P, Alving J, Hansen LK, et al. The misdiagnosis of epilepsy in children admitted to a tertiary epilepsy centre with paroxysmal events. Arch Dis Child 2006; 91(3): 219-21.