

EEG in epilepsy: Sensibility and Specificity

EEG em epilepsia: sensibilidade e especificidade

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ABSTRACT

Objective: the aim of this study was to determine the sensitivity (presence of epileptiform discharges in the EEGs of patients with epilepsy) and specificity (absence of discharges in the EEGs in people without epilepsy) of EEG. **Methodology:** all EEGs performed at the Clinic Santa Vitória, in Campina Grande, PB, from April 2001 to April 2010 were reviewed. All recordings were performed in accordance with international standards for fixing the electrodes, minimum time of registration and methods activation (intermittent photic stimulation and hyperventilation). The reports were divided into 1) patients with epilepsy, previously diagnosed by neurologists, and 2) patients without epilepsy. For both groups, we evaluated the sensitivity and specificity of the EEG. We used SPSS for statistical tests. The study was approved by the Ethics Committee of UEPB. 10,408 EEGs were reviewed. **Results:** epileptiform discharges occurred in 1412 (13.56%). Among those with epilepsy, discharges occurred in 643 (45.57%) - true-positive. Among those who did not have epilepsy, in 54.43% - false positives. From a total of 8,996 (86.44%) EEGs without discharges, 1,276 (14.14%) were from the group of patients with epilepsy - false-negative and 7,720 (85.78%) were from the group of patients without epilepsy - true negative. The positive likelihood ratio test showed that the probability of finding EEG discharges is four times higher among patients with epilepsy compared to those who do not have epilepsy. The negative likelihood ratio test showed no differences between false negative and true negative. In general, a sensitivity of 33.5% and a specificity of 90.9%, with no differences in age and gender was observed. Therefore, EEG showed high specificity but low sensitivity as a diagnostic method in epilepsy.

Keywords: electroencephalogram, epilepsy, sensitivity, specificity

RESUMO

Objetivo: o objetivo deste estudo foi verificar a sensibilidade (presença de descargas em EEGs de portadores de epilepsia) e a especificidade (ausência de descargas em EEGs de sem epilepsia) do EEG. **Metodologia:** foram revisados todos os EEGs realizados na Clínica Santa Vitória, em Campina Grande, PB, no período de abril de 2001 a abril de 2010. Todos os registros foram realizados de acordo com padrões internacionais para a fixação dos eletrodos, tempo mínimo de registro e métodos de ativação (fotoestimulação intermitente e hiperventilação). Os laudos foram divididos em 1) pacientes portadores de epilepsia, previamente diagnosticada por neurologistas, e 2) pacientes sem epilepsia. Para ambos os grupos, estudou-se a sensibilidade e a especificidade do EEG. Foram utilizados testes estatísticos através do programa SPSS. O estudo foi aprovado pelo Comitê de Ética da UEPB. Foram revisados 10.408 EEGs. **Resultados:** descargas epileptiformes ocorreram em 1412 (13,56%). Dentre os portadores de epilepsia, descargas ocorreram em 643 (45,57%) - *verdadeiros-positivos*. Dentre os que não apresentam epilepsia, em 54,43% - *falsos-positivos*. De um total de 8.996 (86,44%) de EEGs sem descargas, 1.276 (14,14%) eram do grupo de portadores de epilepsia - *falsos-negativos* e 7.720 (85,78%) eram do grupo de pacientes sem epilepsia - *verdadeiros-negativos*. O teste de verossimilhança positiva revelou que a probabilidade de ocorrerem descargas é quatro vezes maior dentre os portadores de epilepsia, comparados aos que não apresentam epilepsia. Já o teste de verossimilhança negativa não evidenciou diferenças significativas entre falsos-negativos e verdadeiros-negativos. De modo geral, foi observada uma sensibilidade de 33,5% e uma especificidade de 90,9%, sem diferenças quanto à idade e ao gênero. O EEG apresentou, portanto, alta especificidade, mas uma baixa sensibilidade, como método diagnóstico auxiliar nas epilepsias.

Palavras-chave: eletroencefalograma, epilepsia, sensibilidade, especificidade

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INTRODUCTION

Epilepsy is a neurological condition characterized by repetitive unprovoked seizures¹² due to excessive and uncontrolled neuronal discharges, which may be registered by scalp or deep EEG⁶. EEG is an easy and low costing exam and it has a very important role on epilepsy diagnosis¹². Otherwise, EEG may also be used to classify the epileptic syndromes². Nevertheless, EEG may sometimes lead to mistakes. Some patients with epilepsy may not present EEG interictal discharges and others may have discharges, but not epilepsy. Our objective was to investigate sensibility and specificity of EEG as a diagnostic method for epilepsy.

METHODS

We retrospectively examined EEG recording referred to Santa Vitoria EEG laboratory in Campina Grande, state of Paraíba, Brazil, from April, 2001 to April, 2010. The records were scalp surface routine EEG, EEG following sleep deprivation and they were done with a 20-channel 420 Meditron EEG-recorder. Twenty-one electrodes were placed according to the international 10-20 system. EEGs lasted 20 to 30 minutes including hyperventilation and photic stimulation. Bipolar, longitudinal, transverse, referential and average montages were used. All the EEGs were reported and reviewed by a board-certified neurophysiologist and neurologist. According to the clinical aspects, EEGs were classified into A) patients with diagnosed epilepsy and B) patients with other clinical or neurological conditions or routine examination. For both groups, we determined EEG sensibility (patients with epilepsy with interictal discharges (ID) and EEG specificity (patients with no epilepsy and no ID). This research was approved by the Ethical Committee on Research of the State University of Paraíba. We used a 2x2 contingency table to verify EEG accuracy, sensitivity, specificity, positive and negative likelihood ratio. Sensitivity was determined by the *true positive* rate among epileptic patients. Specificity refers to *true negative* rate among non-epileptic patients. Positive likelihood ratio estimated the occurrence of EEG discharges among epileptic and non-epileptic patients, while negative likelihood ratio estimated the occurrence of the absence of discharges among non-epileptic and epileptic patients. All data were processed by using the Statistical Package for Social Science (SPSS), International Business Machine ® version 20.0.

RESULTS

We reviewed 10,408 EEGs. In general, discharges occurred in 1,412 (13.56%). In group A, discharges were seen in 643 (45.57%) - *true positive*, and in group B, they occurred in 54.43% - *false positive*. Out of 8,996 (86.44%) of non-discharges EEGs, 1,276 (14.14%) were from group A - *false negative* and 7,720 (85.78%) were from group B - *true negative*. Positive likelihood ratio revealed that discharges are four times more likely to appear in patients with epilepsy, when compared to non-epileptic. Negative likelihood ratio showed that there was no significant difference between *false-negative* and *true-negative* EEGs. In general, EEGs exhibited a sensibility of 33.5% and a specificity of 90.9%. Age and gender did not influence the results.

DISCUSSION

SENSIBILITY: EEG sensibility in patients with epilepsy is related to the presence of discharges, while EEG specificity reflects the absence of discharges in non-epileptic patients. In

our research, EEG had a low sensibility (33.5%), as discharges occurred similarly among group A and group B patients.

Ajmone-Marsan and Zivin (1970) reviewed 1,824 EEGs from 308 patients with epilepsy¹. Discharges were seen in 55.5% in the first EEG. After repetitive EEGs, the sensibility raised up to 82.5%, mainly among young patients with temporal lobe epilepsy with frequent seizures. Goodin and Aminoff (1984) found a general sensibility of 52% in the first EEG of 764 patients with epilepsy. Salinsky, Kanter and Dasheiff (1987) analyzed the sensibility of serial EEGs in 429 patients with epilepsy. In the first EEG, they found discharges in 50%; in the third EEG, 84%; in the fourth, 92%. Sleep may also increase EEG sensibility in epilepsy diagnosis¹³. Binnie, Elwes and Polkey (1994) observed that the sensibility rose from 49% to 81% after including sleep EEG³. The age of diagnosis and/or the first EEG may decrease EEG sensibility, although we did not find any differences⁸. Dantas et al. (2005) analyzed 259 EEGs of epileptic patients. They found discharges in 30.1%⁷. González de La Aleja et al. (2008) studied 137 patients with epilepsy. Focal discharges were seen in 42% and diffuse spikes, in 14.6%¹¹. Both results were similar to ours.

SPECIFICITY: in our research, EEG had a high specificity, as 90.9% (non-epileptic patients with no EEG discharges). Others have reported similar results. Zivin and Marsan (1968) analyzed 6,361 EEGs of non-epileptic patients. Discharges were seen only in 2.2%¹⁴. Gregory, Oates and Merry (1993) studied 13,658 EEGs of healthy persons. Only 0.3% had epileptic discharges¹⁰. Bridgers (1987) studied 3,000 EEGs of patients with psychiatric diseases with no epilepsy. Only 2.6% of them had discharges⁴. Cavazzuti, Capella and Nalin (1980) found discharges in 3.5% of 3,716 healthy children⁵. González de La Aleja et al. (2008) reviewed 99 EEGs of patients with non-epileptic ictal features. Only 4% had epileptic discharges¹¹. Discharges in epileptic patients seem to be more prevalent in temporal lobe epilepsy^{1,7,11}. We conclude that EEG has a low sensibility and a high specificity for epilepsy diagnosis. It emphasizes the need of a complete previous clinical evaluation.

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