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Interictal Electroencephalogram: Sensibility in the Diagnosis of Epileptic Seizures in Childhood

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ABSTRACT

Introduction: It is currently estimated that more than 10 million children all over the world have epilepsy and the EEG is the most commonly used diagnostic test in the investigation of these patients. The aim of this study was to analyze the sensibility of the EEG in revealing abnormalities in children with the clinical hypothesis of an epileptic seizure. **Methods:** Out of 970 EEGs obtained between April 2005 and August 2006 at Pequeno Príncipe Children's Hospital, Curitiba, PR, Brazil, 692 fit the criteria proposed (clinical hypothesis of an epileptic seizure after the evaluation of a pediatric neurologist). All EEGs were recorded digitally, with minimal duration of 20 minutes and electrodes positioned according to the International System 10-20. Neonates were excluded. **Results:** Age ranged from 30 days to 16.5 years (mean of 6.4 years and median of 4.1 years), 403 were female (58.2%). Out of the 692 EEG included in the study, 281 (40.6%) yielded abnormal results, 96 (34.2%) with abnormalities of the background activity (disorganization and/or asymmetry) and 185 (65.8%) with epileptiform paroxysms. The sensibility of the EEG was 40.6%. Sharpe wave occurred in 77 cases (41.6%), spike in 21 (11.4%), polispike in 14 (7.6%), spike-wave in 17 (9.2%), polispike-wave in 24 (13.0%) and exams with discharges of more than one morphology in 32 (17.3%). **Conclusion:** Our data strengthen the concept that even though the diagnosis of epilepsy is clinical and based on the semiological description of the epileptic crisis, the EEG has a good sensibility when properly indicated.

Key words: electroencephalogram, epilepsy, seizures.

RESUMO

Eletrencefalograma interictal: sensibilidade no diagnóstico de crises epilépticas na infância

Introdução: Estima-se que mais de 10 milhões de crianças sejam portadoras de epilepsia em todo o mundo e o EEG é o exame mais utilizado na investigação destes pacientes. O objetivo deste estudo foi analisar a sensibilidade do EEG em demonstrar anormalidades em crianças com suspeita clínica de crise epiléptica. **Metodologia:** Dos 970 laudos de EEG realizados entre abril de 2005 e agosto de 2006 no Hospital Infantil Pequeno Príncipe, Curitiba, PR, Brasil, 692 enquadravam-se na metodologia proposta (suspeita clínica de crise epiléptica após avaliação de neurologista infantil). Os EEGs foram realizados em equipamento digital, com duração mínima de 20 minutos e eletrodos posicionados segundo o Sistema Internacional 10-20. Foram excluídos os recém nascidos. **Resultados:** Idade variou entre 30 dias de vida e 16,5 anos (média de 6,4 anos e mediana de 4,1 anos), sendo 403 do sexo feminino (58,2%). Dos 692 EEGs incluídos no estudo, 281 eram alterados, dos quais 96 (34,2%) apresentaram anormalidades da atividade de base (desorganização e/ou assimetria) e 185 (65,8%) paroxismos epileptiformes. A sensibilidade do EEG foi de 40,6%. Descargas de onda aguda ocorreram em 77 casos (41,6%), espícula em 21 (11,4%), polispícula em 14 (7,6%), espícula-onda em 17 (9,2%), polispícula-onda em 24 (13,0%) e exames com descargas com mais de uma morfologia em 32 (17,3%). **Conclusões:** Nossos dados reforçam o conceito de que embora o diagnóstico da epilepsia seja clínico e baseado em dados semiológicos das crises epilépticas, o EEG tem boa sensibilidade quando adequadamente indicado.

Unitermos: eletrencefalograma, epilepsia, crises epilépticas.

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INTRODUCTION

Although the first descriptions of epileptic crisis date from over 3000 years b.C. this theme remains contemporary due to its high incidence in the general population. Epileptic seizures is currently regarded as a neurological disturbance caused by the spontaneous and synchronized depolarization of a restricted area of the cerebral cortex (constituting a focal epileptic crisis) or of large areas of both cerebral hemispheres (constituting a generalized epileptic crisis). The term epilepsy refers to the nosological entity defined by recurrent and unprovoked epileptic crisis. Epidemiological studies concerning seizures and epilepsy reveal a wide variation of incidence rates around the world, probably reflecting differences in classification and methodology.[1] Literature agrees that there is a first peak in incidence in children below 1 year of age, particularly in the neonatal period, and a second peak in the elderly, above the 6th decade. Marino et al.,[2] studying prevalence rates of epilepsy in the state of São Paulo in the 1980's, found 11.9 cases per 1000 inhabitants. Cowan et al.,[3] in a pediatric survey, found prevalence rates of epilepsy in children to be around 5/1.000.

Our study aims to analyze the sensibility of the electroencephalogram (EEG) in demonstrating the pathological abnormalities of the background activity and the presence of epileptiform paroxysms in children with the clinical hypothesis of an epileptic crisis.

METHODS

Nine-hundred and seventy EEG results obtained between April 2005 and August 2006 at the EEG, video-EEG and polysomnography Unit of Pequeno Príncipe Children's Hospital, Curitiba, PR, Brazil, were reviewed. Out of the total of 970 results, the ones indicated by a pediatric neurologist with the clinical hypothesis of an epileptic crisis were selected. The EEGs were obtained in digital equipment, with minimal duration of 20 minutes and electrodes positioned according to the International System 10-20. Neonates were excluded, since epileptic seizures in this age group may have atypical or less characteristic symptomatology. When the same patient was submitted to more than one EEG in the selected period, only the first exam was considered for analysis. For standardization, the background activity was classified as normal (organized and symmetrical) or abnormal (disorganized and/or asymmetrical). The presence and topography of bursts of slow waves and epileptiform paroxysms were evaluated. The latter were classified as sharp wave, spike, polispike, spike-wave, polispike-wave. Concerning their topography, the epileptogenic foci were classified as focal (up to 3 independent foci), multifocal (more than 3 independent foci) and generalized.

RESULTS

Out of the 970 EEG results reviewed, 692 fit the criteria proposed. The patients' age ranged from 30 days to 16.5 years (mean 6.4 years, median 4.1 years). Four-hundred and three were female (58.2%). Out of the 692 exams, 411 (59.4%) were considered normal and 281 (40.6%) abnormal. Ninety-six (34,2%) showed exclusively abnormalities of background activity (disorganization and/or asymmetry) while 185 (65.8%) showed epileptiform paroxysms. When evaluating the proportion of background activity abnormalities and epileptiform paroxysms of the total of EEG included in the analysis (692 exams), these findings occurred in 13.9% and 26.7% of the cases, respectively. The sensibility of the EEG in detecting electroencephalographic alterations in patients with the clinical hypothesis of an epileptic seizure was 40.6%. The morphology of the epileptiform paroxysms was: sharp wave in 77 (41.6%), spike in 21 (11.4%), polispike in 14 (7.6%), spike-wave in 17 (9.2%), polispike-wave in 24 (13.0%) and discharges of more than one morphology in the same EEG register in 32 (17.3%). Topography of the epileptiform paroxysms was focal (up to 3 independent foci) in 120 (64.9%), generalized in 43 (23.2%) and multifocal (more than 3 independent foci) in 22 (11.9%).

DISCUSSION

On July 6th 1924, the German psychiatrist Hans Berger registered for the first time the electrical activity of the cerebral cortex of a 17 year-old adolescent after a skull trepanation for the resection of a brain tumor. In the following year, Berger registered the electrical brain activity of his own son. In acknowledgment of his great contribution to the development of human electroencephalography, Berger is presently considered to be "the father of clinical electroencephalography".[4] Even over more than 80 years of these initial tracings, the EEG remains one of the main diagnostic exams in the investigation of patients with epilepsy, not only for its low cost and simple technique but also for its low risk of complications. Since the first registers in analogical equipments were obtained, electroencephalography has suffered a great deal of improvement, and modernization brought along digital equipments that allow reformatting of montages, new techniques of recording such as electroencephalographic video-monitorization, the use of invasive electrodes and electrocorticography.

The exclusion of neonates (children up to 28 days of age) is based on the fact that in this age group epileptic crisis may have a less clear semiology leading to difficulties in the clinical diagnosis. On the other hand, many paroxystic events of non-epileptic origin cannot be distinguished from epileptic crisis on the grounds of clinical

description only, thus indicating the need for investigation with neonatal polygraphy and other subsidiary exams such as neuroimage. We believe that the inclusion of this group of patients in this study could affect the sensibility of the EEG generating unreliable results. The cerebral maturation is accompanied by the appearance of epileptic crisis with more defined semiology, facilitating its suspicion and clinical diagnosis. Since this study was conducted in an exclusively pediatric hospital, the mean and median ages were low (6.4 and 4.1 years respectively). Concerning sex, we found a balanced distribution, with a slight predominance of females (58.2% × 41.8%).

Dantas et al.[5] in 2005, analyzed the electroencephalographic registers of 259 patients, demonstrating that 113 (43.6%) were altered. In this study, abnormal slowing was observed in 19 cases (7.3%), focal in 11 (4.2%) and generalized in 8 (3.1%). Asymmetric background activity was obtained in 16 patients (6.2%) and epileptiform paroxysms were present in 78 cases (30.1%), generalized in 30 (11.6%), focal in 44 (17.0%) and multifocal in 4 (1.5%). In our study we observed a clear predominance of focal discharges (up to 3 independent foci) when compared to generalized discharges. The preponderance of focal epileptiform paroxysms is in agreement with the study of Dantas et al.,[5] among others. The sensibility observed by Dantas et al.[5] is quite similar to the one observed in our sample, 43.6% and 40.6% respectively. Shinnar et al.[6] also reported a higher prevalence of focal epileptiform paroxysms in children presenting with a first epileptic crisis. Oliveira and Rosado[7] evaluated the sensibility of the non-invasive EEG in detecting abnormalities in patients with epileptic crisis and found higher values than the one reported by our study. After the first EEG, these authors found sensibility values of 50% for electroencephalographic abnormalities, rising to 92% after the recording of a second EEG with activation techniques and prolonged sleep tracings.

Even though the ratio of focal epilepsies (idiopathic or symptomatic) is greater among the pediatric population when compared to generalized epilepsies, the EEG also plays an important role in the diagnosis and classification of the latter. Betting et al.[8] retrospectively analyzed 493 EEG tracings of 180 patients with the diagnosis of generalized epilepsy and reported that 45% had a first normal EEG, 33% had typical EEG results (synchronous generalized spike-wave or polispike-wave discharges with normal background activity) and 22% had atypical EEG results (focal discharges or evident asymmetry of the epileptiform paroxysms). The authors concluded that although the EEG significantly contributes to the diagnosis and classification of the generalized epilepsies, the treatment should be based on the clinical data and the semiology of crisis.

Although certain epilepsies and particularly some epileptic encephalopathies may present during their course with discharges of varied morphology on the electroencephalographic registers, most of the symptomatic focal epilepsies and the idiopathic benign epilepsies of childhood are characterized by the presence of sharp wave paroxysms. In our study, the analysis of the morphology of the epileptogenic paroxysms revealed a marked predominance of sharp wave paroxysms, which is in agreement with the preponderance of focal discharges in the EEG (focal or multifocal epileptiform paroxysms were observed in more than 2/3 of the patients that had discharges in their EEG tracings – 76.8%). The EEG is of great importance not only in aiding to the diagnosis of epileptic crisis but also contributing to their classification, specially when the Classification of Crisis and Epileptic Syndromes by the International League Against Epilepsy of 1989[9] and the Classification proposal of 2001 are used (ILAE 1989, 2001).[10]

Our data further strengthen the concept that even though the diagnosis of epilepsy is fundamentally supported by clinical and semiological aspects, the EEG remains as one of the key subsidiary exams in the investigation and classification of epilepsies and epileptic syndromes, with a good sensibility when properly indicated. In our study the sensibility of the EEG to detect epileptiform paroxysms was greater than the sensibility to identify background activity abnormalities. Due to its relatively low cost, simple technique and good sensibility, the EEG is the routine exam most frequently used in the investigation of patients with the clinical suspicion of an epileptic seizures.

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