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Epilepsy & Behavior 6 (2005) 156–166
Epilepsy & Behavior
www.elsevier.com/locate/yebeh

Predictors of seizure reduction after self-regulation of slow cortical potentials as a treatment of drug-resistant epilepsy☆

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Received 4 August 2004; revised 2 November 2004; accepted 3 November 2004

Abstract

Variables were identified that predict seizure reduction following self-regulation of slow cortical potentials (SCPs) as part of a behavioral self-management program. A sequence analysis across 52 weeks determined 14 patients to have greater than 50% seizure reduction, 8 patients with less than 50% reduction, and 12 patients without improvement. Three variables accounted for 70% of treatment success: (1) cortical excitability at the beginning of training, (2) epileptic focus, and (3) personality variables. Reduction of complex partial and secondary generalized seizures covaried with SCP control attained in the last training session. EEG spectral parameters and cognitive function appeared unrelated to treatment outcome. Successful patients may be those without large negative SCP amplitudes at the beginning of training, without a left temporal epileptic focus, and who score low on life satisfaction and are highly reactive to stress. Patients with complex partial and secondarily generalized seizures may be more likely to experience seizure reduction if they demonstrate good SCP control at the end of their training.

Keywords: Epilepsy; Outcome prediction; Self-regulation; Slow cortical potentials; Behavior therapy; EEG feedback; Neurofeedback

1. Introduction

At least 20 to 30% of all epilepsy patients continue to experience seizures after medication management and are considered pharmacoresistant [1]. Individuals with intractable epilepsy often suffer from focal seizures and only 3% of these patients are candidates for surgical intervention [2]. Approximately two-thirds of all neurosurgical interventions for epilepsy result in complete remission of seizures. As such, at least 15% of all epilepsy patients are not adequately treated by standard medical interventions. This state of affairs has led to the development of adjunct interventions like cognitive behavior therapy approaches for patients [3–5]. In our laboratory, for the first time, a systematic training of self-regulation of brain potentials was integrated in such a behavioral self management program [6].

In several consecutive studies, patients with drug-resistant partial epilepsy were trained to control their slow cortical potentials (SCPs). SCPs reflect DC shifts of the EEG from the upper cortical layer [7,8]. Negative SCP shifts facilitate paroxysmal activity over cortical tissue, and the suppression of cortical negativity corresponds to a state in which epileptic discharge is restricted. While most epilepsy patients can learn to regulate SCPs, there is considerable variability of patient responses. Whereas few patients become seizure-free, about half have a substantial clinical improvement, another quarter

☆ This study was supported by the Deutsche Forschungsgemeinschaft. Niels Birbaumer is supported by the National Institutes of Health.
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doi:10.1016/j.yebeh.2004.11.004

demonstrate only moderate improvement, and the remaining show no improvement at all [6,9]. The reasons for this variability in treatment response are unknown. Identifying factors that predict a patient's clinical success after SCP treatment could have medical, psychological, and economic implications. Knowledge that a specific group of patients are likely to profit from the feedback training could contribute to (1) referral of the most suitable patients for the treatment, (2) a decrease in the frustration and disappointment of patients, and (3) reduction of care costs by minimization of unsuccessful outcomes due to a poor patient treatment match.

Few studies have attempted to identify predictors of success from neurofeedback. In the only published study specifically investigating predictors of successful treatment by SCP training, Daum et al. [10] found that patients with larger attention spans (as measured by means of a block-tapping test) were found to be more successful in seizure reduction than patients with a more limited attention span. In another study of SCP training, subjects who were younger and had greater control over SCPs during transfer conditions (i.e., when feedback is not provided) had greater decreases in seizures [9].

In the present study, we investigated a large clinical sample of patients with intractable partial seizures. SCP feedback training was provided as part of a comprehensive behavioral medicine approach to enhance treatment success [11]. Personality traits and measures of psychosocial adjustment were included in the psychophysiological battery of independent variables to treatment outcome. Our aim was not to separate the effects of the component interventions or to evaluate the general effectiveness; the latter has been already reported [6]. We sought to determine the extent to which seizure characteristics, personality traits, psychosocial adjustment, characteristics of the SCPs, and the response to SCP training contribute to a reduction in seizures.

2. Methods

2.1. Patients

Table 1 represents characteristics of the sample of patients who participated in the study. The patients were selected from two large epilepsy centers on the basis of their having: (1) partial seizures, (2) intractable epilepsy (continued seizures after a minimum of 2 years with appropriate anticonvulsive medications), (3) a seizure frequency of two or greater per month, (4) a full-scale IQ of at least 80, and (5) a minimum age of 15 years. All patients and their physicians agreed not to make changes in anticonvulsant medications, unless medically contraindicated, for a period of 5 months prior to the start of SCP self-regulation training and up to the end of the 1-year follow-up. Patients with a history of psychogenic seizures, other brain diseases, psychotic symptoms, and clinical or neuromorphological signs of frontal lobe damage were excluded. Standard EEG recordings and neurological examination verified neurological diagnosis and exclusion of psychogenic seizures. After this screening procedure patients completed a seizure diary for 12 weeks. In this diary they noted each seizure of that day, its duration, symptoms, antecedents, and consequences. All patients and their relatives were trained at the beginning of the program on how to complete the diary. During the baseline period, as well as during all other nontreatment phases of the study, patients sent their diaries on a weekly basis to the therapist. If there was a delay, patients were reminded by phone.

Table 1
Patient characteristics

Number (gender)	34 (20 female)
Age (years)	Mean 34.2 (SD 7.4, range 17–50)
Duration of illness	Mean 23.0 (SD 8.7, range 7–41) years
Epilepsy syndromes	32 patients with symptomatic localization-related epilepsies 2 patients with epilepsies without unequivocal generalized or focal features
Seizure type	6 patients: only simple partial seizures 12 patients: complex partial and secondary generalized seizures 16 patients: simple and complex partial seizures, 2 of whom also had generalized seizures without focal origin, absences, or myoclonic seizures
Seizure frequency/week	Mean 3.3, SE 1.1, range 0.2–34.4
Education	Mean 10.5 (SD 1.6, range 8–13)
IQ (WAIS)	Mean 104.7 (SD 10.9, range 79–130)
Focus	15 patients: left temporal 9 patients: right temporal 10 patients: uncertain or bilateral
Medication	1 to 3 antiepileptic drugs (mean 1.7); constant medication regime during study period

The study was approved by the ethics committee of Tuebingen University Hospital, and all patients signed a consent form. As patients' IQ scores were within the normal range, it was assumed that the consent forms were understood.

Forty-one patients were included in the study. Due to errors in keeping seizure diaries or changes in the medication regime, data from seven patients were discarded. Patients were identical to those of the original study [6].

2.2. Study design

A summary of the study design is given for those readers unaware of the original study [6]. The study consisted of a baseline phase (12 weeks) prior to the beginning of SCP self-regulation training; the first training phase (3 weeks); the practice phase (8 weeks); the second