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SHORT COMMUNICATION

Long-term effects of electrodermal biofeedback training on seizure control in patients with drug-resistant epilepsy: Two case reports

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Summary We report data from two patients, followed over 3 years after electrodermal biofeedback treatment. Patients were trained three times each week for four weeks to increase their sympathetic arousal using electrodermal biofeedback. This treatment was directed at enabling the patients to change their psychophysiological state as a countermeasure to prevent seizures. Both patients voluntarily kept a record of seizure frequency over the year preceding the treatment and continued to record their seizures for up to 3 years after the termination of biofeedback treatment. Both patients showed a marked reduction in seizure frequency (54.9% and 59.8%) during the month of biofeedback treatment. This improvement was maintained over the subsequent years. We highlight the therapeutic potential of biofeedback interventions that enable patients to volitionally control their state of physiological arousal in the management of drug-resistant epilepsy.

Introduction

Pharmacological treatment is the mainstay in the management of epilepsy. However, even with optimal anti-epileptic drugs, up to 40% of patients with epilepsy remain treatment-resistant (Kobow et al., 2013). Electrodermal biofeedback represents a non-invasive bio-behavioural treatment which teaches the patient to control the sympathetic activity of the skin, demonstrated by changes in skin

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electrical conductance or resistance. We previously reported a successful randomized controlled trial (RCT) of electrodermal biofeedback with 18 patients with drug resistant epilepsy in which 60% of patients in the biofeedback-active group demonstrated a reduction in seizure frequency of 50% or more (Nagai et al., 2004a). The 1 month course of electrodermal biofeedback treatment was also shown to induce changes in cortical potentials measured by electroencephalography (EEG) (Nagai et al., 2009).

Here we report case studies of two middle-aged patients with treatment-resistant epilepsy who participated in our previous RCT and happened to have kept a daily seizure record over 1 year of prior to biofeedback intervention (outside the protocol of 7 months study engagement). They both continued to keep long-term seizure records for up to 3 years after the course of electrodermal biofeedback treatment; these are included in this report. We emphasize that the selection of these patients was based on the presence and utility of their long-term seizure record, which they had voluntarily kept prior to the study. These records illustrated a marked and durable reduction in seizures following the treatment. The study was approved by the Ethics Committee of the National Hospital for Neurology and Neurosurgery. Biofeedback took the form of a computer-generated animation coupled to the measurement of electrodermal activity. The biofeedback administration increased sympathetic arousal. Patients were instructed to drive the animation forward, by as much as possible, through increasing their mental alertness. Sessions lasted 30 min and took place three times a week for 4 weeks. For more details, please see Nagai et al. (2004a).

Both patients had clinical diagnoses of epilepsy confirmed by EEG evidence of epileptic seizures.

Case report 1

The patient suffered from complex partial seizures. Seizure onset was at the age of 13 years old and attributable to childhood meningitis. The seizure focus was broadly localized to the left occipital lobe. At the time of electrodermal biofeedback training, the patient was on medication, namely sodium valproate and phenytoin. Due to involvement of a widespread epileptic network, a surgical procedure was not considered as the potential target was too extensive and diffuse to remove. Most of the seizures occurred during the day without significant aura. The patient described eating and stress as potential triggers that could precipitate seizures. Indeed patient's seizure record revealed a substantial number of seizures occurred during mealtimes, although not necessarily when eating. The patient recognized that seizures also tended to occur in the morning, especially at the time of awakening, and in the evening. The average number of seizures over the 3 months before the treatment was 16.4/month. The patient found that biofeedback treatment was very easy to achieve as directed. After five sessions (near the middle of the treatment course), the patient confidently gained the ability to manipulate physiological state at will. After the month of biofeedback treatment, the patient reported a marked reduction in seizure occurrence. The mean seizure frequency over the 3 months that immediately followed the biofeedback treatment was 7.4/month (a 54.9% reduction) (Fig. 1A). The patient, after the termination of the treatment routinely practiced visualization of the biofeedback session, especially at the time of waking up, as the patient was particularly vulnerable to seizures at this time of the day. A noticeable reduction in the number of early morning seizures was reported. Interestingly, the patient's nocturnal seizures were also evidently reduced. The patient described at a later interview that volitional recollection of the biofeedback imagery helped to abolish impending occurrences of seizures. The patient also mentioned that the most important benefit experienced following biofeedback treatment was stabilization of seizures and the loss of a vicious erratic cycle in seizure number and severity. The patient also reported gaining the self-confidence to control seizures.

Case report 2

The patient was suffering from complex partial seizures on a daily basis for 11 years. The seizure focus was localized in temporal lobe and the option of surgery was offered. However, the patient chose not to pursue surgery by his/her own informed choice. The patient was taking levetiracetam and sodium valproate with limited impact on seizures and hence was referred to adjective electrodermal biofeedback. At the initial interview, the patient reported that subjective anxiety and bodily heating (thermal stress) tended to cause seizures. The patient also often identified changes in taste and smell before the onset of seizures. The average seizure frequency over the 3 months before biofeedback treatment was 329.2/month (Fig. 1B). The patient found that performing the biofeedback task was subjectively very easy and reportedly mastered the skill after three sessions. This was evidenced also by successful modulation of electrodermal activity. The patient showed a dramatic reduction of seizures by the end of the first week of biofeedback sessions. After four weeks of biofeedback training, seizure frequency was reduced to 132.4/month (3 months average after the end of treatment), a 59.8% seizure reduction. Due to obvious preceding gustatory/olfactory aura, the patient was encouraged to employ and maintain the same technique employed during biofeedback training as soon as the patient recognized this aura. By his/her own report, the patient was able to continue to do this after the biofeedback training period. It is noteworthy that in the follow-up seizure chart, the patient started to have some seizure-free days which were not observed during the year of preceding the biofeedback treatment.

Discussion

We report an apparently long-term benefit of electrodermal biofeedback treatment in two patients with drug resistant epilepsy. These case reports suggest that electrodermal biofeedback training can enable processes that impact on the functional circuitry underlying the precipitation and propagation of seizures.

There are some evidences that, in parallel with encouraging the use of effective countermeasures, electrodermal biofeedback training can also evoke more sustained changes in thalamocortical excitability (indexed by EEG cortical slow