NeuroRegulation

Impact of Sensorimotor Rhythm Neurofeedback on Quality of Life in Patients with Medically Refractory Seizures: A Pilot Study

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Abstract

Introduction: Published studies suggest that augmentation of the sensorimotor rhythm (SMR), a commonly-used neurofeedback protocol for patients with epilepsy, changes thalamocortical regulatory systems and increases cortical excitation thresholds. Recent meta-analyses showed that at least 50% of patients with medically refractory epilepsy had a post-therapy reduction in seizure frequency after neurofeedback training. However, data on neurofeedback outcomes outside of seizure frequency are limited. **Methods:** The records for all consecutive patients trained using SMR neurofeedback in the University of Colorado Neurofeedback Clinic prior to March 2015 (n = 9) were retrospectively reviewed, abstracted, and analyzed. Patients completed the Quality of Life in Epilepsy-31 (QOLIE-31) survey as a part of their clinic intake interview and at intervals throughout their training. **Results:** 214 total training sessions were reviewed. The average total QOLIE-31 baseline score in our patients was 49.3 ± 8.8. Seven patients completed follow-up QOLIE-31 surveys with an average score of 54.9 ± 6.5. Seventy-eight percent of the patients had improvement in their QOLIE-31 scores with training. The largest absolute improvements were in the seizure worry and cognitive subscores of the QOLIE-31. **Conclusion:** In this small case series, SMR neurofeedback training modestly improved short-term follow-up QOLIE-31 scores in patients with epilepsy.

Keywords: seizure; epilepsy; sensorimotor rhythm; neurofeedback; quality of life

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Introduction

Epilepsy can be defined as a recurrent predisposition to unprovoked seizures (Fisher et al., 2014). Across the spectrum of persons with epilepsy, seizures occur with a wide range of frequencies and can originate in many different areas of the brain. Approximately 30% of persons with epilepsy are medically refractory, meaning that their seizures are not completely controlled with appropriately chosen and administered antiseizure medications (Kwan et al., 2010). Comorbid mood disorders are common in patients with epilepsy, affecting 40–70% of patients at some point in their lifetime, with depression and anxiety the most commonly reported (Hermann, Seidenberg, & Bell, 2000).

Quality of life (QOL) can be defined as a subjective perception of a patient's own wellness/functionality. QOL is multidimensional and, in patients with epilepsy, is influenced by multiple interacting factors. These factors include: degree of seizure control, psychiatric comorbidity, medication side effects, socioeconomic status, and strength of social support network. Two of the most important factors associated with QOL in patients with medically refractory epilepsy are symptoms of depression and seizure worry (Loring, Meador, & Lee, 2004), suggesting that both seizure and non-seizure

manifestations of epilepsy contribute to a patient's QOL.

Neurofeedback is a form of biofeedback that assesses and analyzes EEG signals to help train individuals to produce healthier brain rhythms. In the case of people with epilepsy, these rhythms are those that are less likely to be proconvulsant. Neurofeedback can be a powerful tool for reregulation of the dysfunctional brain rhythms that are driving the clinical manifestations of epilepsy. Augmentation of the sensorimotor rhythm (SMR) is a commonly used neurofeedback protocol for patients with epilepsy. Published studies suggest that augmentation of the SMR changes thalamocortical regulatory systems and increases cortical excitation thresholds (Sterman, 2000; Sterman & Egner, 2006). As such, SMR augmentation can be an effective means of reducing seizure frequency in patients with medically refractory seizures (Sterman, 2000; Sterman & Egner, 2006; Tan et al., 2009). Recent meta-analyses assessing neurofeedback training in patients with medically refractory epilepsy showed that at least 50% of patients had a post-therapy reduction in seizure frequency (Sterman 2000; Tan et al., 2009). Many protocols for depression and/or anxiety, common psychiatric comorbidities in patients with epilepsy, also involve training within the sensorimotor cortex (Soutar & Longo, 2011). As such, there is potential for SMR training to affect both seizure and non-seizure manifestations of epilepsy. The data on neurofeedback outcomes outside of seizure frequency are currently limited, however. This case series will explore whether SMR neurofeedback training in patients with epilepsy potentially impacts overall QOL.

Methods

The records for all consecutive patients trained using SMR neurofeedback (see below for protocol details) in the University of Colorado Neurofeedback Clinic prior to March 2015 (n = 9) were retrospectively reviewed. This study was reviewed and approved by the Colorado Multi-Institutional Review Board (COMIRB) as an exempt study.

Data on patient demographics, duration of epilepsy prior to training, seizure types and frequencies, antiepileptic drugs (AEDs), degree of seizure control, psychiatric and medical comorbidities, imaging results, neurophysiological results, Quality of Life in Epilepsy-31 (QOLIE-31) scores, and the duration of neurofeedback training were abstracted and analyzed. Patients in this clinic routinely complete the QOLIE-31 survey as a part of their clinic intake interview and at intervals throughout their training. The QOLIE-31 is a validated, epilepsy-specific, QOL measure that measures constructs such as: seizure worry, emotional well-being, energy/fatigue, cognition, medication effects, and social function (Borghs, de la Loge, & Cramer, 2012). In this measure, higher scores represent greater patient-reported QOL. The reported minimal clinically important change for the total QOLIE-31score is between 5 and 12 points (Borghs et al., 2012; Wiebe, Matijevic, Eliasziw, & Derry, 2002). Patients also reported the number of seizures experienced each week before each session.

All patients were trained by a certified neurofeedback provider (LF) using a BrainMaster Atlantis system (BrainMaster Technologies, Inc., Bedford, Ohio). The training protocol rewarded increased amplitude of the 12–15 Hz frequency band and, simultaneously, decreased amplitude of the 4–8 Hz (theta) frequency band at Cz. A second (also simultaneous) inhibit of the 4–8 Hz (theta) frequency band was included at a second site if the individual had a focus of increased theta amplitude outside of C3, Cz, or C4 on their baseline quantitative EEG (qEEG). Training was performed using 2-min training intervals for at least 20 total training minutes per session and one session per week.

For descriptive means of population descriptors and QOLIE scores and subscores, all patient measures were averaged. For the mean change in QOLIE-31 scores and subscores, the change in QOLIE-31 score for each patient was calculated and then averaged over all patients.

Results

A total of 214 training sessions were reviewed. Summary data for our patient population are given in Table 1. One of the seven patients remained seizure-free throughout training. Five of the other six patients reported a subjective decline in seizure frequency or severity.

Table 1
Summary data for case population

Population Descriptor	Summary Data
N	9 patients
Total number of training sessions studied	214 sessions
Mean number of training sessions per patient (± SEM)	22.8 ± 4 sessions
Gender	4 male; 5 female
Mean patient age (± SEM)	47.4 ± 5.9 years
Mean duration of epilepsy prior to training (± SEM)	18.7 ± 3.6 years
Mean number of antiseizure drugs (± SEM)	1.7 ± 0.3
Focal onset epilepsy syndrome?	8 of 9 patients
Structural lesion on MRI?	4 of 9 patients
History of comorbid mood disorder	7 of 9 patients
Number of patients with both initial and follow-up QOLIE-31 scores	7 of 9 patients

Note. SEM = Standard error of the mean

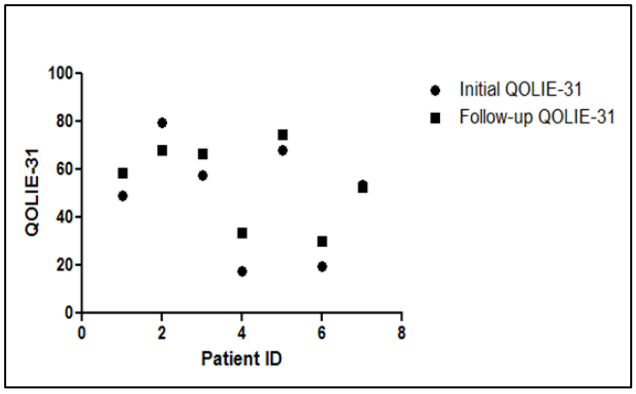

Figure 1. Total QOLIE-31 scores before and after at least 18 sessions of SMR neurofeedback training.

All nine patients completed the QOLIE-31 at the beginning of their training with an average baseline score of 49.3 ± 8.8. Seven patients completed follow-up QOLIE-31 surveys. Initial and follow-up total QOLIE-31 scores for these seven patients are plotted in Figure 1. Five of the seven patients (78%) had an absolute improvement in their follow-up total QOLIE-31 score. One patient's follow-up score was essentially unchanged, and one patient's follow-up score reflected a worsening of reported QOL after training.

As shown in Table 2, the mean (± SEM) post-training QOLIE-31 score was 54.9 ± 6.5 (*n* = 7). The changes in QOLIE-31 scores from initial to follow-up measure averaged 5.6 ± 3.4 (range: -11.6 to 16).

Table 2
QOLIE-31 summary data

QOLIE-31 Parameter	Summary Data
Mean QOLIE-31 score before training (± SEM)	49.3 ± 8.8
Mean QOLIE-31 score after training (± SEM)	54.9 ± 6.5
Mean QOLIE-31 change with training (± SEM)	5.6 ± 3.4
Range of QOLIE-31 score changes	-11.6 to 16
Percent of patients with QOLIE-31 improvement after training	78%

Note. SEM = Standard error of the mean

Table 3 shows the mean (± SEM) of each subscore of the QOLIE-31 before and after neurofeedback training (*n* = 7). Pairs with changes greater than 5 points are highlighted in red. The largest absolute improvements were in the seizure worry and cognitive domains of the QOLIE-31.

Table 3
Mean (± SEM) subscores of QOLIE-31 before and after neurofeedback training

QOLIE-31 Subscore	Before Training	After Training
Seizure Worry	47.7 (± 10.8)	54.0 (± 9.9)
Overall QOL	62.1 (± 9.1)	68.9 (± 4.9)
Emotional Well-being	64.6 (± 8.5)	68.6 (± 6.9)
Energy/Fatigue	41.4 (± 10.5)	44.3 (± 8.1)
Cognitive	44.9 (± 8.5)	54.7 (± 6.0)
Medication Effects	40.5 (± 15.9)	40.5 (± 12.5)
Social Function	41.9 (± 14.9)	44.3 (± 11.0)

Note. Pairs with changes greater than 5 points are highlighted in red

Discussion

In this small case series of patients with medically refractory epilepsy, SMR neurofeedback training improved QOLIE-31 scores, with an average change of 5.6 ± 3.4. The reported minimal clinically important change for the total QOLIE-31score is between 5 and 12 points (Borghs et al., 2012; Wiebe et al., 2002). This range encompasses our finding within the lower end of this range, suggesting that our mean change in QOLIE-31 scores, although modest, may be clinically meaningful. This is the first study that we are aware of that looks at QOL after NFB training in persons with epilepsy.

While QOL in persons with epilepsy is heavily influenced by the degree of seizure control, we know that both seizure and non-seizure manifestations of epilepsy contribute to a patient's QOL (Loring et al., 2004). The improvements in QOLIE-31 scores in our series of medically refractory patients occurred despite a range of changes in seizure control in the individual patients, supporting this concept.

There are a number of limitations to this study. First, we had a small sample size, limiting our power to detect differences between mean QOLIE-31 scores at our two time points. This also limited our analysis to descriptive statistics only. Secondly, our results are based on a subjective measure done only once at two individual time points. Future studies may need to include repeated measures before and after training to try to adjust for day-to-day variability and/or mood dependence of subjective QOL scores.

Overall, in our series of patients with medically refractory epilepsy, we documented modestly improved follow-up QOLIE-31 scores after SMR neurofeedback training, although larger studies are needed to confirm the value of the QOLIE-31 as an outcomes measure. In addition, larger studies are also needed to determine the psychosocial constructs that may underlie changes in QOL after neurofeedback training in patients with epilepsy.

References

Borghs, S., de la Loge, C., & Cramer, J. A. (2012). Defining minimally important change in QOLIE-31 scores: Estimates from three placebo-controlled lacosamide trials in patients with partial-onset seizures. *Epilepsy and Behavior, 23*(3), 230–234. http://dx.doi.org/10.1016/j.yebeh.2011.12.023

Fisher, R. S., Acevedo, C., Arzimanoglou, A., Bogacz, A., Cross, J. H., Elger, C. E., ... Wiebe, S. (2014). ILAE Official Report: A practical clinical definition of epilepsy. *Epilepsia, 55*(4), 475–482. http://dx.doi.org/10.1111/epi.12550

Hermann, B. P., Seidenberg, M., & Bell, B. (2000). Psychiatric Comorbidity in chronic epilepsy: Identification, consequences, and treatment of major depression. *Epilepsia, 41*(Suppl. s2), S31–S41. http://dx.doi.org/10.1111/j.1528-1157.2000.tb01522.x

Kwan, P., Arzimanoglou, A., Berg, A. T., Brodie, M. J., Hauser, W. A., Mathern, G. W., ... French, J. (2010). Definition of drug resistant epilepsy: Consensus proposal by the ad hoc Task Force of the ILAE Commission on Therapeutic Strategies. *Epilepsia, 51*(6), 1069–1077. http://dx.doi.org/10.1111/j.1528-1167.2009.02397.x

Loring, D. W., Meador, K. J., & Lee, G. P. (2004). Determinants of quality of life in epilepsy. *Epilepsy and Behavior, 5*(6), 976–980. http://dx.doi.org/10.1016/j.yebeh.2004.08.019

Soutar, R., & Longo, R. (2011). *Doing Neurofeedback: An Introduction*. San Rafael, CA: ISNR Research Foundation.

Sterman, M. B. (2000). Basic concepts and clinical findings in the treatment of seizure disorders with EEG operant conditioning. *Clinical EEG and Neuroscience, 31*(1), 45–55. http://dx.doi.org /10.1177/155005940003100111

Sterman, M. B., & Egner, T. (2006). Foundation and practice of neurofeedback for the treatment of epilepsy. *Applied Psychophysiology and Biofeedback, 31*, 21–35. http://dx.doi.org/10.1007/s10484-006-9002-x

Tan, G., Thornby, J., Hammond, D. C., Strehl, U., Canady, B., Arnemann, K., & Kaiser, D. A. (2009). Meta-analysis of EEG biofeedback in treating epilepsy. *Clinical EEG and Neuroscience, 40*(3), 173–179. http://dx.doi.org/10.1177 /155005940904000310

Wiebe, S., Matijevic, S., Eliasziw, M., & Derry, P. A. (2002). Clinically important change in quality of life in epilepsy. *Journal of Neurology, Neurosurgery, and Psychiatry, 73*, 116–120. http://dx.doi.org /10.1136/jnnp.73.2.116

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