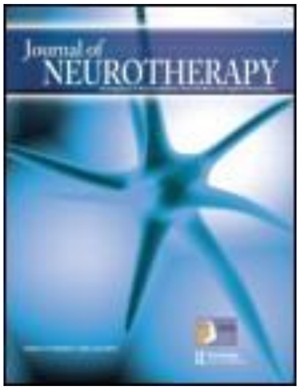

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Neurofeedback Treatment of Type I Diabetes Mellitus: Perceptions of Quality of Life and Stabilization of Insulin Treatment-Two Case Studies

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Neurofeedback Treatment of Type I Diabetes Mellitus: Perceptions of Quality of Life and Stabilization of Insulin Treatment– Two Case Studies

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ABSTRACT. *Background*. This article is a case study review of the neurofeedback treatment of two female subjects with Type I diabetes mellitus. Both women had received regular medical treatment including the use of a restricted diet and short-term insulin treatment using an insulin pump. The study sought to discover the effects of neurofeedback treatment on the individuals' perceptions of their quality of life and, any effects on measured glucose blood levels.

Method. Both the subjects received 20 sessions of neurofeedback training. These sessions took place three times a week, each session lasting approximately 45 minutes to 1 hour. The treatment consisted of training at C3, C4, and interhemispheric (C3-C4). The women were given symptom report checklists following each session and were interviewed prior to beginning of the treatment, at the conclusion of the 20 sessions, and 16 days after their final session. The interviews focused on self-reported changes in symptoms and the effect of these changes on their quality of life. Both the women also recorded their daily glucose levels and insulin dosage throughout the study.

Results. The subjects reported improvement in their perception of their quality of life (QOL). Additionally, both reported improvement in glucose levels as well as fluctuations and reduced dosages of insulin required on a daily basis.

Discussion. The existing research on the effectiveness of neurofeedback training for a broad variety of physical and emotional problems lead us to wonder if it might be helpful for either the physical or emotional aspects of Type I diabetes mellitus. Given the higher incidence of this condition, the significance of this research was considered to be important. The results of the study provide preliminary evidence that neurofeedback can be an important and valuable treatment for both the physical and emotional symptoms associated with Type I diabetes mellitus. Furthermore, research with larger numbers and stricter controls in the field is warranted. doi:10.1300/J184v10n04_03

KEYWORDS. Diabetes, neurofeedback, glucose levels, quality of life, insulin, interhemispheric

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BACKGROUND

Diabetes mellitus (DM) is an illness in which the body does not produce or use insulin properly. There are 18.2 million people in the United States, 6.3% of the total population, who have been diagnosed with DM. About 800,000 people in the United States have been diagnosed with type I DM, for which there is no cure. They are at greatest risk for heart attack, stroke, and diabetes-related diseases of the eyes, kidneys, and nerves. Not surprisingly, many people with diabetes feel helpless, which often leads to poor management of their illness (Graap & Freides, 1998). Most studies report worse quality of life (QOL) for people with DM compared to the general population, especially regarding physical functioning and psychological well-being (Glasgow et al., 1999; Rubin, 2000). For the purposes of this study, QOL is defined as personal satisfaction (or dissatisfaction) with the cultural or intellectual conditions under which one lives. Quality of life is an important consideration in medical care and additionally refers to the patient's ability to enjoy normal activities. Rubin and Peyrot (1999) reported that medical outcomes of diabetics are truly meaningful only to the extent that they affect their physical, emotional, and social well-being; in other words, their QOL. This study measured QOL in a qualitative interview format, and with the completion of a symptom report checklist.

Biofeedback is best known in the area of stress management and relaxation training. It has been shown to help individuals cope with stress effectively and gradually shift to a more relaxed state in order to overcome different disorders (Surwit, 2002). Furthermore, mind-body intervention techniques such as diaphragmatic breathing and the use of autogenic phrases have been applied successfully for the treatment of DM (McGrady, Bailey, & Good, 1991). A variety of studies related to the effectiveness of neurofeedback training for stress, anxiety, Post Traumatic Stress Disorder, and test anxiety have indicated that it is an equally effective intervention (Rice, Blanchard, & Purcell, 1993; Peniston, Marrinan, Deming, & Kulkosky, 1993; Moore, 2000). Considering the above noted successes of other modalities of biofeedback on diabetes mellitus, and the positive results of neurofeedback training for the treatment of stress and anxiety, it seems logical and appropriate to conclude that EEG biofeedback may help to alleviate the effects of stress in diabetic patients. The anticipated result of this study was confirmed directly from the patients who reported improvements in their quality of life and also an increased physiological stability.

While there is no current literature supporting the effects of neurofeedback training in this area, the authors hope to lay groundwork for future replication of findings and to promote exploration of neurofeedback in the treatment plans of patients with diabetes and other types of chronic illness.

METHOD

Subjects

Two adults with type I diabetes mellitus participated in this study. Both participants utilized an insulin pump and were on restricted diets.

Instrumentation

EEG biofeedback equipment manufactured by Neurocybernetics was used. This is a two-computer configuration in which the EEG is displayed in waveform on the therapist's computer and the different waveforms of interest are separated, displayed, and controlled. A second computer and monitor displays the results of the controlled waveforms in a video game format with both auditory and visual cues, which provide the feedback mechanism for the client. All protocols entailed a single reward band of either 15-18 Hz at C3, 12-14 Hz at C4, or 11-14 Hz at C3-C4 (bipolar), and simultaneous inhibits of 4-7 Hz and 22-36 Hz. The program offers visual and auditory reward each time all of the conditions are met.

Procedure

Each client participated in a qualitative interview and was asked to describe their perception of their quality of life, particularly as it related to the presence of diabetes in their lives. In addition, each client filled out a symptom checklist developed for general use with the author's neurofeedback clients. The checklist consisted of a listing of a broad variety of conditions along side of a Likert Scale. They were asked to rate any conditions that they felt were problematic in their lives. The checklist was given again at the conclusion of the 20 sessions of training and a third time at the post-treatment follow-up. Each subject also made a daily recording of blood glucose levels and amount of insulin injected. Both subjects were interviewed again at the conclusion of treatment and 16-days post-treatment and were asked to report on any perceived changes in their quality of life as a result of the training.

The method for determining protocol selection was Othmer's Over/Under arousal/instability model (Othmer, 2005b). This model links particular symptoms to a hypothesis as to the brain's baseline function which, in turn, determines a beginning strategy for a treatment protocol. Under arousal, as represented by such symptoms as depression, low energy, poor sleep maintenance, or a low pain threshold is addressed by training at C3, 15-18 Hz. Over arousal, as represented by symptoms such as impulsivity, agitation, and aggression, is addressed by training at C4, 12-15 Hz. Instability issues are addressed using a bipolar interhemispheric protocol such as C3-C4 with variable frequency settings tailored to the individual client. Using the Othmer's model to guide site selection, the authors chose C3, C4 at the reported frequencies to balance left side beta and right side SMR. Left side training has traditionally been more effective and comfortable with a slightly higher frequency reward than for right side training (Othmer, 2005a).

The protocol in this study was decided upon by considering the client's presenting symptoms. Rather than varied fluctuations of frequencies at these sites, training was dependent on the time spent at each location. Both subjects began training using a mix of C3, 15-18 Hz and C4, 12-15 Hz. Adjustments were made in response to self-reports of well-being by regulating the amount of time spent at each site. This protocol was maintained throughout training for Subject 1 (see Table 1).

Subject 2 did not report a significant improvement in symptoms as training progressed and hence at session number 10, it was determined to change her protocol to interhemispheric C3-C4. Interhemispheric training was decided upon with the anticipation that there would be an added effect from challenging the brain to coordinate activation between two sites (Othmer, 2005a). Since interhemispheric training may be thought of as optimizing the reward frequency for each individual, the symptomology pre-

TABLE 1. Neurofeedback Training Protocol for Subject 1.

Subject 1, NFB Training Protocol				
Training Session	Monopolar Training	Inhibit Band (Delta & Theta)	Inhibit Band (High Beta)	Reward Band (SMR)
1	C3, 15 minutes C4, 15 minutes	4-7 Hz (Theta) 4-7 Hz (Theta)	22-36 Hz 22-36 Hz	15-18 Hz 12-15 Hz
2	C3, 12 minutes C4, 18 minutes	"	"	"
3-5	"	2-7 Hz (Delta & Theta) 2-7 Hz (Delta & Theta)	"	"
6-10	C3, 9 minutes C4, 21 minutes	"	"	"
11-20	C3, 6 minutes C4, 24 minutes	"	"	"

sented by this subject encouraged the authors to target physiological manifestations along the sensory motor strip. An initial frequency of 12-15 Hz was used as a standard beginning point for interhemispheric training at C3-C4. Based on subjective reports, the frequency was dropped to 11-14 Hz in the reward band when the subject reported feeling calm, relaxed, and focused, with 2-7 Hz and 22-36 Hz inhibits (see Table 2). Training continued here for the duration of the sessions.

RESULTS

The data showed that the participants described their experiences as pleasant and rewarding. They emphasized two issues that helped improve their QOL: (a) receiving the neurofeedback training, and (b) having the opportunity to talk about some problems in their lives which they had not discussed with anybody before. The participants itemized the improvements that they experienced with regard to the following issues: (a) improvements in their unpleasant symptoms, (b) improvements in managing the symptoms of their illness, (c) lowering the fluctuations of their blood glucose levels and the dosages of the insulin taken on a daily basis, (d) experiencing overall calmness and feeling more relaxed, (e) being able to view their family and financial problems more clearly, (f) improvements in their self-efficacy by feeling more energetic and tolerant when coping with their challenges in life, (g) becoming able to think more rationally and optimistically about their life challenges, and (h) thinking that there could be more options in the future than what they previously believed to be available to them. Significant improvements were also reported by both subjects in blood glucose levels and a reduction in the amount of insulin required.

Subject 1 reported a total average blood glucose level of 189 mg/dl with a total average of 1.6 mg of insulin injection for the 16-day pre-treatment period. The total average glucose level dropped to 152 mg/dl and the average insulin injection dropped to 1.3 mg during the 45-day treatment phase. At the 16-day post-treatment measure, the total average glucose was 136 mg/dl and the average insulin injection was 1.3 mg.

Subject 2 reported an average glucose level of 185 mg/dl and average insulin injection of 1.8 mg at the pre-treatment measure. Average glucose levels of 148 mg/dl and average insulin injection of 1.5 mg during treatment and 119 mg/dl glucose with 1.5 mg of insulin at post-treatment follow-up. The daily measures of both the subjects can be seen in Table 3.

TABLE 2. Neurofeedback Training Protocol for Subject 2.

Subject 2, NFB Training Protocol				
Training Session	Monopolar Training	Inhibit Band (Delta & Theta)	Inhibit Band (High Beta)	Reward Band (SMR)
1	C3, 15 minutes C4, 15 minutes	2-7 Hz (Delta & Theta) 2-7 Hz (Delta & Theta)	22-36 Hz 22-36 Hz	15-18 Hz 12-15 Hz
2-5	C3, 12 minutes C4, 18 minutes	”	”	”
6-10	C3, 9 minutes C4, 21 minutes	”	”	”
Interhemispheric Training				
11	C3-C4, 30 minutes	”	”	12-15 Hz
12-20	”	”	”	11-14 Hz

TABLE 3. Averages of the Two Participants' Glucose Levels, Ranges of Glucose Fluctuations, and Insulin Injections.

	Subject 1			Subject 2		
4-day intervals	Avg. glucose levels (mg/dl)	Avg. range of glucose fluctuation	Avg. insulin injections (mg)	Avg. glucose levels (mg/dl)	Avg. range of glucose fluctuation	Avg. insulin injections (mg)
16-day pre-study period						
13-16	195	42	1.6	183	47	1.8
9-12	190	58	1.6	210	50	1.8
5-8	187	33	1.5	179	60	1.7
1-4	185	54	1.5	168	46	1.8
45-day NFB training period						
1-4	197	61	1.6	170	50	1.7
5-8	175	32	1.5	165	72	1.7
9-12	190	29	1.6	200	35	1.8
13-16	178	52	1.4	155	37	1.7
17-20	170	72	1.4	164	66	1.7
21-24	165	49	1.3	180	46	1.7
25-28	142	27	1.3	156	49	1.5
29-32	105	30	1.1	125	39	1.4
33-36	122	19	1.2	110	59	1.3
37-40	130	47	1.2	93	36	1.2
41-45	101	20	1.1	115	42	1.3
16-day follow-up period						
1-4	124	54	1.3	125	36	1.4
5-8	180	44	1.5	130	40	1.4
9-12	110	62	1.2	97	61	1.3
13-16	132	59	1.2	125	48	1.3

Notes: *4-day interval*. The numbers on each row represent the averages of a period of four days during which the data were collected.

16-day pre-study period. During this period, the researchers collected the data of 16 days immediately prior to the first day of the study in which the first interview was conducted. There were four intervals during this period.

45-day NFB training period. The data were collected for the entire period of the 20 training sessions. This period began on the 1st session and continued throughout the 20th session covering a 45-day period. There were 11 intervals during this period.

16-day follow-up period. The researcher collected the data of 16 days immediately following the last day of the neurofeedback training. There were four intervals during this period.

DISCUSSION

Neurofeedback has been generally regarded as an effective means of enhancing the brain's ability to manage and recover from stress by enhancing the brain's flexibility and resilience. It was hypothesized that improved stress management should be reflected in an individual's perception of improvement in his or her own QOL. This was indeed the case for both of the subjects of this study. Both the subjects reported that their lives had improved considerably and both attributed the change to the neurofeedback training. It was further hypothesized that improved QOL might result in improved stability in glucose levels since the literature provides evidence that increased stress has a negative effect on physiological function (Surwit & Schneider, 1993). This was confirmed by the daily measures that each subject recorded throughout the study. The results of this study for these women were remarkable and provide a sufficient rationale for additional study with this population. Considering that diabetes is projected to reach epidemic proportions in the United States in coming years, discovering precisely how neurofeedback could be an effective component of treatment is all the more critical.

The results of this study should be viewed with caution. The results of only two subjects means the results cannot be generalized. External influences such as change in diet or lifestyle were not controlled, though neither subject gave any indication that they had radically changed anything in their lives. All of the measures, including blood glucose and insulin levels were self-reported and no external objective reports were obtained. It should be emphasized, based upon the reports of the subjects, that an important element of their perceived improvement in quality of life was a result of their simply having the opportunity to talk with someone about how they felt and how diabetes had affected their lives. It is possible that this factor alone might be related to the reported improvement.

However, it should also be noted that what might be called "significant conversation" only took place three times over the 72 total days of the study. It is doubtful that such limited discussion would be sufficient to institute the level of change reported. Likewise, the significant level of improvement in the glucose and insulin measures during neurofeedback treatment might indicate a profound effect of the treatment itself.

As noted above, diabetes has become an significant health issue in the U.S. Type I Diabetes usually has onset in childhood and presents profound repercussions for the child, their families and for society. The repercussions include not only physical limitations and consequences but also issues related to QOL as well (Rose et al., 1998).

We believe that the reported improvements in quality of life are as important a finding in this study as the significant improvements in the physical measures. As the medical treatment of diabetes clearly demonstrates, medicine can sometimes ameliorate the physical symptoms of the disease but often at a cost to the individual's happiness and global sense of well-being. A second potential asset of neurofeedback training may be its ability to enhance and improve an individual's attitude toward life as well as their physical symptoms.

REFERENCES

Glasgow, R., Fisher, E., Anderson, B., LaGreca, A., Marrero, D., Johnson, S., et al. (1999). Behavioral science and diabetes: Contributions and opportunities. *Diabetes Care*, *22*, 832-843.

Graap, K., & Freides, D. (1998). Regarding the database for the Peniston alpha-theta EEG biofeedback protocol. *Applied Psychophysiology and Biofeedback*, *23* (4), 265-272.

McGrady, A., Baily, B. K., & Good, M. P. (1991). Controlled study of biofeedback-assisted relaxation in type I diabetes. *Diabetes Care*, *14* (5), 360-365.

Moore, N. C. (2000). A review of EEG biofeedback treatment of anxiety disorders. *Clinical Electroencephalography*, *31* (1), 1-6.

Peniston, E. G., Marrinan, D. A., Deming, W. A., & Kulkosky, P. J. (1993). EEG alpha-theta brainwave synchronization in Vietnam theater veterans with combat-related post-traumatic stress disorder and alcohol abuse. *Advances in Medical Psychotherapy*, *6*, 37-50.

Othmer, S. (2005a). Interhemispheric EEG training. *Journal of Neurotherapy*, *9* (2), 87-96.

Othmer, S. (2005b). Protocol Decision Tree Manual. www.EEGSupport.com

Rice, K. M., Blanchard, E. B., & Purcell, M. (1993). Biofeedback treatments of generalized anxiety disorder: Preliminary results. *Biofeedback & Self-Regulation*, *18*, 93-105.

Rose, M., Burkert, U., Scholler, G., Schirop, T., Danzer, G., Klapp, B. F. (1998). Determinants of quality of life of patients with diabetes under intensified insulin therapy. *Diabetes Care*, *21*, 1876-1883.

Rubin, R. (2000). Diabetes and quality of life. *Diabetes Spectrum*, *13*, 21-29.

Rubin, R., & Peyrot, M. (1999). Quality of life and diabetes. *Diabetes/Metabolism Research and Reviews, 15,* 205-218.

Surwit, R. S. (2002). Stress management improves long-term glycemic control in type II diabetes. *Diabetes Care*, *25*, 30-34.

Surwit, R. S., & Schneider, M. S. (1993). Role of stress in the etiology and treatment of diabetes mellitus. *Psychosomatic Medicine*, *55* (4), 380-393.

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