NeuroRegulation

Treating Postchemotherapy Symptoms with Neurofeedback

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Abstract

Treatment for cancer often involves surgery, chemotherapy, and/or radiation. As a result of these interventions, studies have found that patients often experience prolonged side effects posttreatment. This case study focuses on a 62-year-old woman who was diagnosed with breast cancer and underwent surgery and chemotherapy. The patient was treated with 30 sessions of neurofeedback over the course of 2 weeks. Utilizing a combination of three different neurofeedback protocols, the patient reported significant improvements in cognitive and physical functioning.

Keywords: neurofeedback; chemotherapy; cancer; case study

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Introduction

Treatment for cancer often involves surgery, chemotherapy, and/or radiation. A comprehensive cancer treatment protocol is often a combination of some or all of these modalities, each of which can produce significant unwanted side effects. Being under general anesthesia, especially for extended periods of time, affects the brain and brain function (Storrs, 2014). Additionally, a team of researchers at the University of Rochester Medical Center and Harvard Medical School have posited that a common chemotherapy drug known as 5-fluorouracil (5-FU) is responsible for what is commonly referred to as "chemo brain," which is associated with significant decay of healthy neurons even after the use of the drug has ceased (URMC, 2008). Fortunately, there might be a way to moderate the impact of these interventions for patients. This article will briefly review the effects of anesthesia and chemotherapy on the brain and then describe a successful case of neurofeedback treatment with a postsurgery, chemotherapy, and radiation therapy breast-cancer patient.

Chemotherapy

It is common knowledge that cancer patients treated with chemotherapy experience a variety of negative and generally unpleasant side effects that often include, but are not limited to, depression, anxiety, short-term memory loss, difficulty concentrating, not being able to think clearly, connect thoughts or concentrate on daily tasks, and, in extreme cases, seizures, vision loss, and even dementia (Bruno, Hadi Hosseini, & Kesler, 2012; McDonald & Saykin, 2013; Nokia, Anderson, & Shors, 2012; Raffa & Tallarida, 2010; Silverman & Davidson, 2009). In fact, a study conducted by researchers with the James P. Wilmot Cancer Center at the University of Rochester showed that upwards of 82% of breast cancer patients reported that they suffer from some form of cognitive impairment (Michaud, 2008). In addition to cognitive difficulties, patients commonly experience chemotherapy-induced peripheral neuropathy, a physically debilitating condition with a range of symptoms including numbness, tingling, complete loss of sensation, pain, extreme cold sensations, or heaviness to name a few (Kolb et al., 2016; Tofthagen, Kip, Passmore, Loy, & Berry, 2016). These changes inhibit activities of daily living such as driving a car, eating with utensils, dressing, and even walking. The scientific community in general continues to acknowledge that many chemotherapy agents may have a negative impact on brain function in some cancer patients. Unfortunately, the precise mechanisms that cause the brain's dysfunction have not been identified and have been difficult to pinpoint.

The side effects of chemotherapy usually diminish over time. However, follow-up studies have shown that some patients experience deleterious effects long after the conclusion of their treatments (Jim et al., 2012). In some cases, 15–20% of women who were treated for breast cancer experienced persistent cognitive problems after chemotherapy treatment, and 50% of women in one study had not returned to their baseline levels of cognitive functioning one year after chemotherapy treatment (URMC, 2008). These researchers also remarked that since chemotherapy clearly degenerates functions in the central nervous system, and this drug is likely to be the standard of care for the foreseeable future, it is imperative that science find methods of moderating the negative effects imposed by its use.

Anesthesia

Many patients diagnosed with cancer undergo surgery, which frequently requires the use of an anesthesia. Symptoms of postoperative delirium, a state of serious confusion, and memory loss are often associated with being under anesthesia. In addition to hallucinations, delirious patients may forget why they are in the hospital, have trouble responding to questions, and speak in nonsensical sentences (Storrs, 2014).

The iatrogenic effects from anesthesia generally begin to dissipate after one or two days. However, studies in the past 4 years suggest that a high enough dose can in fact raise the risk of delirium after surgery (Storrs, 2014). Recent studies also indicate that the condition may be more damaging than previously believed. Delirium (which often includes confusion and disorientation) can last at least a few hours and require patients to stay one night or longer in the hospital. It is also more common after major surgeries, and recent research over the past several years has revived anesthesia as a potential culprit in delirium (Storrs, 2014). Deep anesthesia has also been linked to subtler but longer lasting cognitive problems. In fact, some physicians have indicated that the effects of anesthesia on the brain can last upwards of one year or longer, and older individuals are more likely to have longer lasting negative effects (Perouansky & Hemmings, 2009).

Neurofeedback & Chemotherapy

The use of neurofeedback to moderate side effects from chemotherapy is not a new inquiry (Alvarez, Meyer, Granoff, & Lundy, 2013). Additionally, neurofeedback has been used specifically to treat pain in cancer patients (Prinsloo, Gabel, Lyle, & Cohen, 2014). The nervous system's fundamental feature is its neuroplasticity, that is, its ability to adapt to changing environmental conditions. A recent investigation showed that neurofeedback can lead to changes in human cortical excitability and that neurofeedback creates positive changes in both the gray and white matter of the brain (Ghaziri et al., 2013). These researchers proposed that alterations in the brain's white matter might support cognitive enhancement. They also noted that there is evidence that myelination is still sensitive to experiences during adulthood, therefore suggesting that neurofeedback might also lead to increased myelination. As mentioned earlier, chemotherapy has been linked to degeneration of the neurons, so it naturally follows that neurofeedback could be of significant benefit to counteract such effects.

Patient Background

Tiffany (name changed) is a 62-year-old, divorced white female who was initially diagnosed with breast cancer in July 2011. She underwent a lumpectomy in the same month with follow-up treatments that included postsurgical chemotherapy (four treatments of "red Devil") and radiation therapy as a precautionary measure. Radiation therapy began 4 months after her diagnosis on her right side only and consisted of 26 daily sessions. She reportedly tolerated it well with a little numbing in her toes. Postsurgical report indicated no lymph nodes or surrounding tissue were cancerous.

Unfortunately, in March 2013, Tiffany was diagnosed with recurrence of breast cancer, in the same spot of the incision for the lumpectomy. Tiffany underwent a right mastectomy that same month. A different chemotherapy drug combining tomaxifin together with adriamycin, cytoxan, and taxol (ACT) chemotherapy was administered postsurgery. Tiffany immediately noticed numbness and pain in her fingertips, toes, feet, and lower leg and reported this right away. Tiffany reported very different, worsening, and severe side effects from the chemotherapy including feeling tired and dehydration. Her blood work indicated that she had a low red blood count. The doctors attempted to mediate the side effects by altering her chemotherapy treatment, but she continued to have worsening and severe side effects. Tiffany decided to cease her chemotherapy treatments after four sessions. Six months after her recurrence of cancer, Tiffany had a left mastectomy and reconstructive surgery to create pockets for implants. She was under anesthesia for the duration of the 7-hr surgery. Six months later, and 1 year after her recurrence, she had a final surgery in which implants were placed in the pockets created during the previous surgery.

Tiffany's medical history also includes a diagnosis of Diabetes Type II, which is controlled through Metformin 500 mg daily. She had participated in a weight loss program, and her A1C dropped to below the diabetic number; her diabetes is now controlled through diet. However, Tiffany was informed that Metformin could be helpful in resisting the return of cancer so she continued to take one tablet daily. Although Tiffany has normal and stable blood pressure, she takes blood pressure medication as a result of her parental heart history. Tiffany also takes Crestor to control cholesterol. Tiffany was active until age 60, has never smoked, and reportedly drinks a glass of wine or two daily. Tiffany also reported having routine mammograms and two breast reductions in 2004 and 2007 due to breasts being fibrous and cystic. Tiffany was unable to drive a car and unable to perform routine work requirements and was eventually terminated from her employment.

Neurofeedback Treatment

Due to follow-up doctors' appointments, Tiffany was only able to devote 2 weeks to her neurofeedback treatment. The decision was made to provide treatment sessions twice per day and three times on weekend days in order to provide a total of 30 sessions within the timeframe. Tiffany arrived at the office for treatment midweek in the beginning of September 2013. Her presentation upon arrival included poor sleep, numbing in hands and arms, and her balance was limited and required her to walk with a cane. When standing, she had to hold onto a solid object to keep her balance. Before beginning her treatment, Tiffany was informed that the clinician expected she would experience significant improvements in sleep and cognitive functioning. It was also stated that there was a chance other symptom relief could occur through neurofeedback treatment. She agreed to participate in her treatment and for her results to be included in research.

In addition to her neurofeedback training, Tiffany was encouraged to use mental imagery regarding walking balance and increased feeling in hands and feet, and she was encouraged to practice diaphragmatic breathing multiple times per day. Tiffany was asked to give periodic verbal progress reports when she noticed any significant changes or improvements.

Tiffany was administered multiple quantitative electroencephalograms (qEEG) to measure her brain functions both pre- and postintervention. Several years before her treatment, qEEG data was collected solely because she was interested to learn about her brain. Pertaining to her neurofeedback treatment, Tiffany was administered a pretreatment qEEG at the beginning of her treatment in September, and two posttreatment qEEGs 1 month and 7 months after her neurofeedback treatment. The New Mind Center (Roswell, GA) qEEG analysis service was utilized for all of her qEEG assessments. A comparison of these brain maps at three time points (pretreatment, 2-month posttreatment, and 7-month follow-up) is presented in Figures 1 and 2.

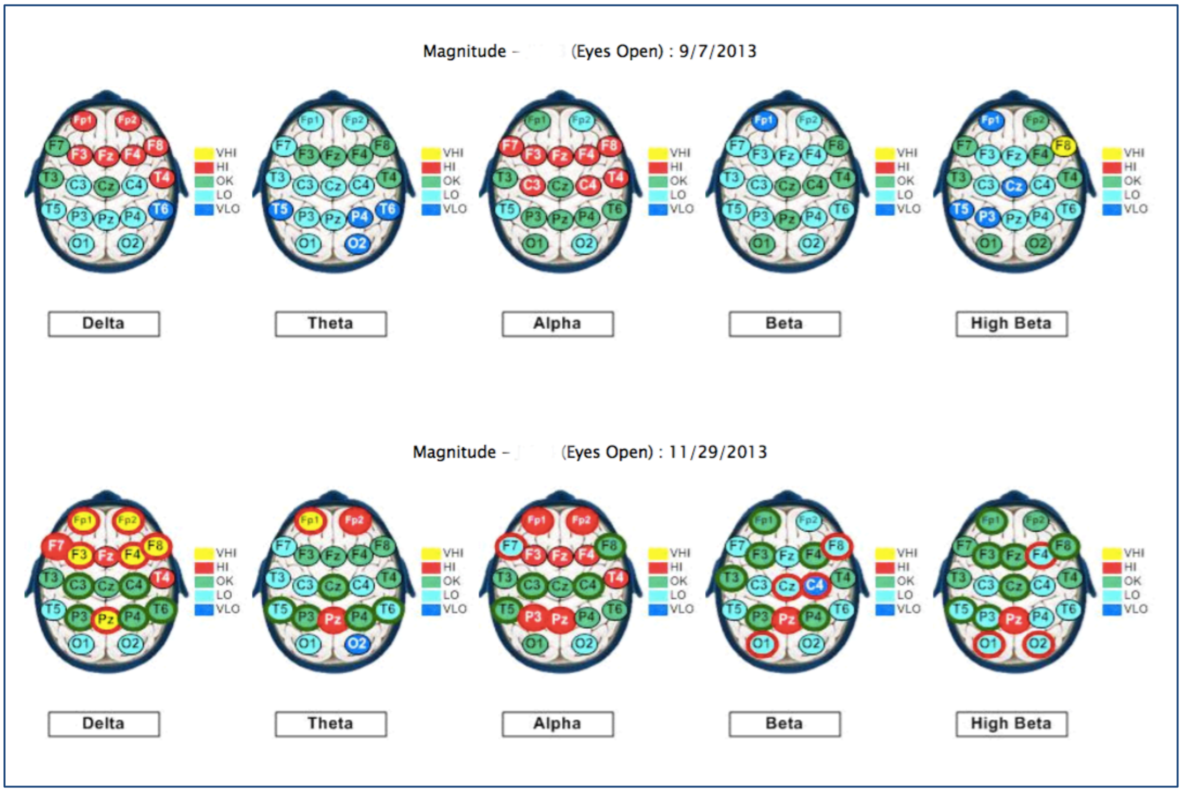

Figure 1. Comparison of qEEG results September (pretreatment) to November (2-month posttreatment). VHI = Very High, H = High, LO = Low, VLO = Very Low.

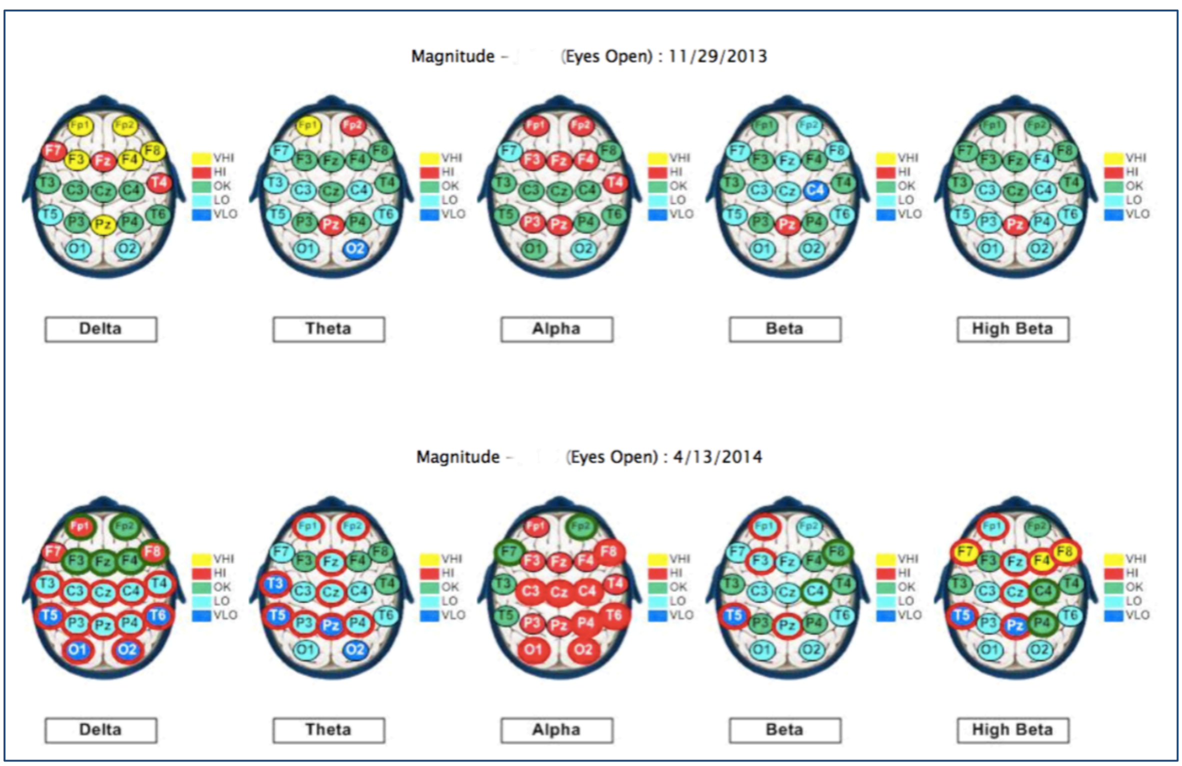

Figure 2. Comparison of qEEG results November (2-month posttreatment) to April (7-month follow-up). VHI = Very High, H = High, LO = Low, VLO = Very Low.

Tiffany began neurofeedback treatment the day after her arrival. Her protocols were derived from her qEEG data and are presented in Table 1. The clinician used an Atlantis I 4x4 system (BrainMaster Technologies, Inc, Bedford, OH). All protocols used a monopolar placement and were administered with the patient's eyes closed. Protocol 1 was single-channel training, and protocols 2 and 3 were two-channel trainings. A description of her course of treatment is presented in Table 2. She reported improvements in sleep and balance after the first day with continued gains by day two including increased sensations in her fingertips. She reported increased flexibility and sensation in her lower extremities during days three to four, and continued improvements in balance and range of motion in her feet through day seven. On the seventh day, she also reported being able to drive a car again. She reported similar gains in subsequent sessions with continuous improvements each day. These findings are supported by data from her pre and post brain maps.

The qEEG analysis service used in this case provides multiple metrics including magnitude, dominant frequency, coherence, and asymmetry are for each qEEG. For purposes of this case for which two-channel magnitude training protocols were used, and due to limited space, only changes in magnitude are presented in Figures 1 and 2. As the comparisons illustrate, the brain does not always heal by moving towards the norm. Often the brain's reorganization results in increases or decreases in magnitude yet the patient reports continued improvement as illustrated in Table 2 below.

Table 1
Neurofeedback Protocols Used During Training

Electrode Site	Inhibit Hz	Reward Hz	Inhibit Hz
Protocol 1			
Cz	2–10	13–15	16–30
Protocol 2			
C3	2–10	13–15	21–30
C4	2–7	13–15	21–30
Protocol 3			
T3	2–12	15–20	
T4		13–15	16–30

Table 2
Course of Treatment

Day #	Date	# of Sessions	Protocols	Observations
1	Sep 5	2	1, 2	Improved sleep and balance
2	Sep 6	2	1, 2	Improved sleep and balance, more energy, increased sensations in fingertips
3	Sep 7	3	2, 3	Could move feet up and down and also bend feet tippy toe which couldn't do before
4	Sep 8	3	2, 3	Felt a sensation (not painful) from mid body down to her feet during protocol three
5	Sep 9	2	1, 3	Better balance and walking a little better, better range of motion in feet
6	Sep 10	2	3	Better balance and walking a little better, better range of motion in feet, standing on toes
7	Sep 11	2	2, 2	Better balance and walking a little better, better range of motion in feet, standing on toes; was able to drive car
8	Sep 12	2	1, 2	Continued improvements related to symptoms noted on previous day
9	Sep 13	2	2, 3	Continued improvements related to symptoms noted on previous day
10	Sep 14	3	1, 2, 3	Continued improvements related to symptoms noted on previous day
11	Sep 15	3	1, 2, 3	Continued improvements related to symptoms noted on previous day
12	Sep 16	2	1, 2, 3	Continued improvements related to symptoms noted on previous day
13	Sep 17	2	1, 2, 3	Continued improvements related to symptoms noted on previous day

Summary

Many patients experience iatrogenic effects following the administration of chemotherapy (URMC, 2008). Because the use of such drugs is common practice in cancer treatment, it is important to provide patients with methods to relieve their distress. There is limited research on the use of neurofeedback to treat physical health issues related to balance, walking gait, and neuropathy. However, this single case study offers promising evidence that these conditions might be addressed and improved with neurofeedback treatment. Further research in treating neuropathy should be conducted in order to assess the benefits and efficacy of neurofeedback for this condition.

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