Biofeedback Self-Regulation Training to Treat Post-Concussion Headache in a Special Operations Support Soldier

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ABSTRACT

Biofeedback assisted self-regulation training can be an effective treatment for post-concussion headaches. The following is an example of using biofeedback assisted self-regulation training as an intervention to treat post-trauma headaches in a Special Operations Forces (SOF) support soldier. This Soldier was a 23-year-old male who had suffered a concussion while off duty four months earlier and continued to experience headache. Three-modality biofeedback (temperature, surface electromyogram and skin conduction) was used to help the patient learn to self-regulate and control his headaches. This was accomplished over four visits over two weeks. This was a compressed timeline to allow him to deploy with his unit. This form of treatment can be a viable non-medication based option for addressing post concussion headaches for deploying Soldiers.

Introduction

Post-concussion headache can have characteristics of either tension type headache, migraine type headache, or both.[1] Head injuries, specifically minor traumatic brain injury (mTBI) and traumatic brain injury (TBI), have been a significant concern for our troops with the employment of improvised explosive devices on the battlefield. Hoge, McGurk, Thomas, Cox, Engel, and Castro[2] reported that in one brigade of the 2,525 Soldiers sampled, nearly 15% reported a head injury during a combat deployment to Iraq. This is consistent with other studies that found the rates of post-concussive headache to be about 15%.[3,4] Theeler and Erickson[5] reported that 41% of returning Soldiers who presented with headache in specialty care reported they sustained a head injury while deployed. Clearly post-concussion headache is a concern for the U.S. Army. Biofeedback has been a demonstrated effective treatment for migraine as well as tension type headaches.[6,7] Chronic tension type headache is effectively addressed through surface electromyogram (sEMG) biofeedback self-regulation.[7] Blood-volume-pulse and thermal focused biofeedback are more effective for migraine type headache.[6] Therefore sEMG, peripheral temperature, and also skin conduction would be the modalities for biofeedback assisted self-regulation training for this case.

History

A 23-year-old single male enlisted (E-4) SOF support Soldier who suffered frequent (nearly daily) headaches after a concussion was referred by his physician to psychiatrically clear him for deployment and to address his headaches. He sustained a head injury during an altercation while off-duty four months earlier. During the event he experienced no loss of consciousness or any amnesia, but he did have mild confusion. He also sustained a fractured nose. He denied alcohol intoxication at the time of the incident. Shortly after the event, a computed tomography (CT) scan revealed blood in the ethmoid sinus and likely the maxillary sinus. He was treated with tramodol and acetaminophen with oxycodone for his head pain with some relief after the initial concussion. He had blurry vision for several days after the event. He demonstrated difficulties with memory and arithmetic calculations 45 days after the event. He reported that he had difficulties expressing himself and indicated that he had always had difficulties with maintaining attention.

He had a prior concussion two years earlier during a "hard landing" while conducting an airborne landing. He had headaches for a short time after the parachuting incident as well. He reported that the headaches resolved spontaneously from his earlier concussion but not the most recent one.

He had a neuropsychological assessment at two months post-event that revealed residual language, memory, and attention deficits. He was placed on methylphenidate to improve his attention. He was not able to remain on tramadol and be able to deploy. At almost three months post-incident he had improved in all areas of functioning

with the exception of headache. He and his treatment team were largely pleased with the results. He was preparing and eager to deploy to a combat zone. However, he was not able to deploy due to recently being placed on the methylphenidate. The policy for deployment to CENTCOM is that a Soldier is to be stable on that particular medication at that dose for 90 days.[8] He had not yet reached the 90-day mark while stable on the methylphenidate.

His physician had cleared him for deployment and initiated the process to gain a waiver from requisite medical authorities. At the same time a referral was made to a clinical health psychologist for his attention difficulties and headache and to evaluate for other potential psychiatric problems. The patient's medical record was reviewed and the patient examined. Most of the post-concussion symptoms were absent save the attention challenges and headaches. This was consistent across all evaluators (e.g., primary care physician, neuropsychologist and the treating clinical health psychologist). He complained of headaches for the four months after the incident. He described his headaches as "feeling like a balloon being overfilled" in the front of his head (frontal) on most days. He typically would rate this as 7 out of 10. He endorsed mild photophobia associated with the headache at times. He reported that over the counter medications did not help his headache. He was offered, and agreed to, biofeedback assisted self-regulation training as a non-pharmacological treatment option. Normally treatment sessions would be weekly. The treatment was to be condensed in hope that he would receive a waiver to deploy with his unit.

Assessment

A baseline self-regulation assessment was conducted using multimodal biofeedback instrumentation. This included resting, attempt at relaxation, mild stressor, and then another attempt at relaxation conditions. Measurements included sEMG on bi-frontalis, skin conduction from the first and third fingers on his non-dominate hand (left), and peripheral temperature from the second finger on his non-dominate hand. The values for the assessment can be seen in Table 1 for each modality providing the mean and standard deviation for each one minute condition. The Soldier exhibited a good response. He was able to relax himself during both relaxation periods to a degree as seen in decreases on sEMG, as well as skin conduction. He also exhibited a good response to the mild stressor as seen in increases in activity on both sEMG and skin conduction. However, his peripheral temperature was low (approximately 62° F) with low variability for all conditions. This condition is consistent with less parasympathetic response and could have implications for his headache. Furthermore, greater reduction of muscle tension as seen in lower sEMG activation would also be desirable.

Treatment

The plan was to use biofeedback-assisted self-regulation training to reduce and or eliminate his headache. The training was to start with a progressive muscle relaxation (PMR) protocol of three sessions. PMR is a relaxation technique where patients tense muscles to acquire awareness of that muscle group and then use that awareness to enhance a relaxation response. The patient tenses and relaxes each muscle group in the body. This would be followed by autogenic relaxation training protocol again for three sessions. Autogenic relaxation is when a patient uses autosuggestion as well as awareness of body sensation to gain a relaxation response. Direct feedback would complete the treatment for about nine sessions. Direct feedback is when the patient uses the biofeedback monitors to change their physical response. All of the modalities employed in the assessment would be continued in the treatment. Table 1 shows the mean and standard deviations for the final two minutes of each training session. The treatment course was condensed to several meetings a week rather than once per week to attempt to gain control of the soldier's headache while allowing him to deploy with his unit.

His first training session was conducted during the same visit as his baseline assessment. Unfortunately the temperature instrumentation failed to work during his initial

Table 1 *Biofeedback to Address Post Trauma Headache*

	sEMG mean (SD)*	SC mean (SD)	Temp. mean (SD)
Assessment (full 1 min condition)			
Rest	3.23 (4.20)	6.45 (0.17)	63.1 (0.09)
Relax	2.45 (0.72)	6.52 (0.05)	63.1 (0.02)
Stress	4.67 (0.75)	7.13 (0.19)	63.1 (0.04)
Relax	2.93 (1.24)	6.12 (0.13)	63.1 (0.03)
Treatment (final 2 min of training)			
PMR 1#	1.87 (0.74)	5.34 (0.19)	—
PMR 2	2.72 (0.50)	9.92 (0.57)	92.6 (0.49)
PMR 3	1.96 (0.57)	6.68 (0.08)	88.4 (2.48)
Autogenic Relaxation	2.21 (0.48)	2.17 (0.08)	94.3 (0.14)

Notes: *Surface electromyogram (sEMG); Skin conduction (SC); and peripheral temperature in Fahrenheit (Temp)
Progressive muscle relaxation (PMR)

training. This was unfortunate particularly due to the poor response he had had during the assessment in this modality. However, he was able to make improvements on both sEMG, from an average of 4.32 millivolts (mv) to an ending mean of 1.87mv. During the session he had improvement on skin conduction as well, with a reduction from an average of 7.24 micro Siemens (μs) to a mean of 5.34 μs. He was to practice the PMR daily.

He reported one headache between his first and second training session three days later. During the second training session he made improvements on peripheral temperature (ending value of 92.6° F). His response on skin conduction was poor with an ending value of 9.92 μs when compared to his first training session. His ending value of 2.72mv for sEMG can be considered a fair response.

During his third training session, he had a very good response across all modalities ending with a sEMG of 1.95mv, skin conduction of 6.68μs, and a peripheral temperature of 88.4° F. Interestingly he reported a mild headache during this session which corresponded with a drop in his peripheral temperature to 64.4° F. He was able to resolve his headache and increase his peripheral temperature. In the interval leading to his next visit, he reported experiencing one headache that he was able to resolve using self-regulation techniques (PMR). He was very pleased with the results and confident in his abilities to control his body's responses.

His fourth training session was autogenic relaxation. He performed fairly well on two of three modalities. He achieved ending values of skin conduction of 2.17μs and a peripheral temperature of 94.3° F. However his sEMG (2.21mv) was not as low as optimal or as low as he obtained in the past. He was to return in a few days to continue treatment; however, the waiver was granted allowing him to deploy to Iraq.

He continued to be headache free after the four biofeedback training sessions over two weeks. While in Iraq he was monitored by his physician. He denied having problems with headache while deployed or after his return.

Discussion

This Soldier was very motivated to be rid of his headaches and so he was likely adherent to his at-home practice. This is probably the most important contribution to the treatment. He exhibited fairly good self-regulation skills as seen in his baseline assessment, which likely contributed to his positive response to the treatment. He developed the skills to better self-regulate more quickly than most people. Typically treatment takes about six weeks to allow enough practice time. The support that his unit provided him and their eagerness to have him remain a part of the team were also likely important factors providing a reinforcing effect. Similarly, coordination with the Soldier's physician was another important factor for effective assessment and referral as well as subsequent monitoring. All of these factors combined were important for this Soldier to obtain control over his headaches. He had intense headaches nearly daily prior to treatment and was able to become headache free.

Conclusions

While there is a good deal of literature on the treatment of tension as well as migraine headache with biofeedback there has been only very sparse published material on post-traumatic headache and biofeedback and no controlled trials that I could find. Further trials and studies should be conducted on the use of biofeedback for post-traumatic headache. Addressing blast- related post-traumatic headache should be specifically investigated due to the prevalence of this means of injury during combat. Concussion-induced headache can be a vexing problem. This is particularly true for a military population during war. This case study demonstrates the potential of using biofeedback to address post trauma headaches. Although the present case is not blast-related, and this Soldier's response to training can be seen as quicker than most, the application holds promise for other service members with trauma-induced headache. This is particularly true for SOF Soldiers who are generally highly motivated and may prefer and benefit from non-medication based treatments for headaches so as to be available for world-wide deployment.

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