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Combat Veteran effectively treated with Stellate Ganglion block and Hyperbaric Oxygen Therapy.

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Abstract

A Vietnam combat veteran with a positive history of Post Traumatic Stress Disorder was successfully treated with ultrasound guided stellate ganglion block and hyperbaric oxygen treatment. Cognitive EEG testing was done prior to the intervention and then again at three months showing improvement in cognitive functioning. The PCL-C questionnaire was utilized to assess the severity of the PTSD symptoms, which also improved post treatment. There is varying literature on the recommendations of SGB and HBOT treatments in this population and we proposed that additional research is warranted for treatment of these complex individuals to improve their quality of life thus positively affecting productivity and functionality within society.

Keywords: Stellate Ganglion Block, SGB, hyperbaric oxygen, HBOT, EEG spectrum analysis, Post traumatic stress disorder, PTSD

Introduction

Post-Traumatic Stress Disorder (PTSD) is a chronic anxiety disorder that is caused by experiencing a traumatic event; this event can occur in civilians and in the military. The American Psychiatric Association recognized PTSD as a medical condition and included this diagnosis in the third edition of the DSM-III in 1980. The diagnostic criteria for PTSD in 1980 are different than what it is today. Initially it was events such as natural disasters, torture, rape, war, and human made disasters that were clearly different than "ordinary stressors" of life (Friedman, 2007). This diagnostic criterion was revised in the 1987, 1994, 2000 and again in 2003. Diagnostic criteria for PTSD now require a systematic approach. This involves identifying factors that include stressor criterion, symptoms, duration, functional and exclusion factors (Center for Substance Abuse Treatment, 2014). Furthermore, the symptoms clusters include intrusive recollection, avoidance criteria, negative cognitions, and alterations in arousal or reactivity (Center for Substance Abuse Treatment, 2014). The symptoms much persist for at least one month, the symptoms must affect social, or occupation areas of life and the symptoms cannot be due to medication, substance use or other illnesses (Friedman, 2007).

PTSD is the most diagnosed service-related mental disorder among U.S. military veterans and is the third most common psychiatric diagnosis (Gradus, 2007). There remains reluctance for those service members to seek out mental health services. PTSD can be debilitating and lead to a decrease in quality of life as it can negatively impact social, financial and relationship status of the individual (Gradus, 2007). PTSD has been found to increase the risk of suicidality and substance abuse disorders. The current lifetime prevalence of PTSD, according to the U.S. Department of Veteran's Affairs, is 3.6% among men and 9.7% among women (Gradus, 2007). This number changes when looking at specific populations of war veterans. For instance, the estimated prevalence of PTSD among American Veterans who served during the Vietnam era was estimated at 30.9% for men and 26.9% for women and this was estimated from the National Vietnam Veterans Readjustment Study conducted between 1986 and 1988 (Gradus, 2007). It is an important distinction to make that certain situations can have a greater or lesser impact on the population of interest.

There is research that indicates that PTSD may be associated with neurobiological alterations affecting the central and autonomic nervous system. This can be seen as a hyperarousal of the sympathetic nervous system (Peterson et al., 2017). Functional brain imaging can identify increase and reduction in specific areas of the brain for those patients who suffer from PTSD. The proposed mechanism of action of the SGB is that it might inhibit connections between the

peripheral sympathetic nervous system and regions of the cerebral cortex that is abnormally activated in patients who suffer from PTSD (Peterson et al., 2017).

Current treatment recommendations for PTSD include screening followed by cognitive behavioral therapy (CBT) and medications. The majority of the medications include selective serotonin reuptake inhibitors (SSRIs) such as sertraline or paroxetine among others. SSRIs can take 4 to 8 weeks to work, have a discontinuation rate of almost 50% and are only effective in half the population (American Psychological Association, 2017). CBT can occur in an individual or group treatment session. Engaging with others who have suffered similar experiences can be therapeutic, however there is not empirical support for this intervention but does show promising results. Alternative treatments such as hyperbaric oxygen has been researched in areas such as traumatic brain injury, stroke, wound healing and psychiatric conditions; however, the protocols vary so the evidence does not currently support this intervention in its current state as a primary treatment option.

A recent evidence brief from the Veteran's Affairs indicates that targeted review of outcome measures for hyperbaric oxygen therapy specific to PTSD and mild traumatic brain injury is unclear on long term improvement in terms of functionality of the patient (Parr et al., 2021). The authors do mention that the features of hyperbaric may lead to improved patient's symptoms in those patients with PTSD and without traumatic brain injury (Parr et al., 2021). HBOT has been found to reduce inflammation specific to the central nervous system, increase vascularization, alter immune cell function and release stem cells (Boussi-Gross et al., 2013). At lower pressures (less than or equal to 2.0 ATA) the risk of barotrauma or adverse events is minimized, this indicates a need for additional research in the realm of hyperbaric specific to PTSD.

Additionally, a SGB or Stellate Ganglion Block has been identified as a promising intervention in veteran's who suffer from Post-Traumatic Stress Disorder. The stellate ganglion is a part of the sympathetic nervous system and is a cluster of nerve cell bodies that is located between the C6 and C7 vertebra. An SGB involves the injection of a local anesthetics, such as lidocaine, delivered under ultrasound guidance by an experienced practitioner at the stellate ganglion which is found at the level of the 6th cervical vertebra (Lipov, 2022). The SGB has been used for several mental and musculoskeletal health conditions dating back to 1947 including depression, social phobia, hot flashes, upper extremity pain and complex regional pain syndrome and was first used in PTSD by Dr Lipov in 2008 (Lipov, 2022). There are now randomized controlled studies that revealed that SGB

can significantly improve PTSD symptoms such as anxiety, pain, physical functioning, mental functioning, and distress (Lipov, 2022).

In 2014, Navaie and associates reviewed and summarized available literature regarding SGB treatment in the case of PTSD. The studies at that time were mostly case study reports but showed that the primary treatment group appropriate for SGB trial were those patients who received more than 1 year of psychotherapy and pharmacology (2014). The majority of the patients within the study were predominately male and active-duty military or war veterans (Navaie, et al., 2014). In a case series of 166 patients by Mulvaney (2014), the PCL-M questionnaire was utilizing to screen, diagnose, and determine response to intervention. The PCL-M has a strong internal consistency, reliability and validity with other PTSD measures and has been endorsed by the National Center for PTSD (2022). Using this questionnaire, a score of 35 is generally the threshold for screening miliary populations and a change of 10 points is considered to be clinically meaningful (National Center for PTSD, 2022). Mulvaney and associates found that patients who scored greater than 50 on the PCL-M had a greater response to SGB than those that that's that scored below 50 (2014). It is important to mention that those patients who scored below 50 also had a positive improvement, just not as dramatic. This literature suggests that SGB may provide at least 3 months of relief and a second injection is just as effective as the first. The authors suggest that SBG injections should be a part of a comprehensive PTSD treatment protocol and not utilized as a stand-alone treatment option (Mulvaney, 2014).

WAVi Background

In this study, we will investigate the success of SGB by using WAVi, a 19-channel electroencephalogram (EEG) headset and software device that was used on the patient in different stages of therapy in order to check and validate the intervention. The EEG measures that have been investigated in this study include EEG evoked potentials (ERP), spectra markers and coherence analysis.

ERP By trying to investigate the simplest approach that produce acceptable test-retest variance, WAVi typically reports the amplitudes of the P300 components measured by identifying the positive extremum in the latency range of 240–500 ms. The depth (P300V) is then extracted from the mean amplitude of all stimuli and the latency (P300T) is the delay recorded for that depth. WAVi baseline corrects these independent ERP epochs using the 100 ms pre-stimulus period. The P300 depth has been identified as a parameter that can be affected by PTSD and conditions that affect cognition (Butt et al., 2019).

Spectra Spectral analysis characterizes the frequency composition of EEG (Dessler 2004 and Dumermuth 1987), and can be used to identify peak frequency changes in PTSD patients. An individual's peak alpha frequency (IAF) is considered a stable marker of a neurophysiological trait and can therefore provide longitudinal mental health information on a patient (Grandy et al., 2013) Slowing of the IAF has been observed in patients with PTSD (Butt et al., 2019). To be consistent with the clinical nature of this study, the alpha peak frequency and power spectra were extracted during the auditory P300. Again, all groups were consistently compared using the same alpha amplitude metric.

Connectivity Alpha band coherence was extracted using standard methods described elsewhere (Srinivan 2007). As with the spectral analysis described above, eyes-closed coherence measures were extracted during the same eyes-closed P300 protocol. There are many methods of presenting coherence, but with N x (N-1)/2 = 171 pairs to choose from, care must be made to not overfit the data. One method adopted here is a simple procedure where we calculated the number of connections that are stronger than an age-matched reference by counting the number of connections larger than 2 standard deviations (2 σ). Taken as the control, the pre-injury baseline group averages 3 connections above 2 σ out of the 171. If PTSD leads to more connections, particularly long-distance ones, then this method will allow for quantification of pre-post schanges. We used alpha band coherence because it is less susceptible to motion artifacts and/or muscle tension than the other bands, and because alpha often accounts for the greatest amount of power in the EEG band, and thus the most robust coherence estimates.

Patient background information and Care History

A relationship was started with this 69-year-old Caucasian male patient in approximately 2008 for a shoulder concern. This initial treatment was successful and contributed to a trusting patient provider relationship. He sought treatment in 2018 regarding his shoulder pain which was due to a rotator cuff tear and secondary adhesive capsulitis. Additional treatments were provided for this location of concern which eventually led to his visit in February 2020. In February 2020 he presented to the clinic for a SBG sympathetic block for his ongoing regional shoulder pain understanding that it may also have some added benefit in decreasing post-traumatic stress disorder symptoms. Patient is a Vietnam war combat veteran with diagnosed anxiety and depression with complaints of difficulty sleeping, vivid dreams and flashback images of service events. He also has significant physical abuse trauma from childhood. A review of medications at that visit had him on sertraline 50 mg, bupropion hcl

ER 150 mg, ropinirole 2 mg, tamsulosin ER 0.4 mg, metformin 500 mg BID, levothyroxine 25 mcg daily and aspirin 81 mg daily. He has a long-standing history of medication managed diabetes and neuropathy. He reported no nicotine or alcohol use at the time. Previous treatments specific to the left shoulder pain included steroid injection, physical therapy, platelet rich plasma injection, nonsteroidal anti-inflammatories, and lyophilized regenerative injection.

On February 2020 the patient was prepped for a L middle cervical sympathetic ganglion block under ultrasound guidance. This was successfully done by injecting 1.8 cc 1% lidocaine, 2.2 cc traumeel and 1.2 cc neuralgo-rheum. Patient reported pre injection pain to the left shoulder as a 7-8 out of 10, where 10 is the worst on the VAS pain scale. No formal PTSD questionnaire was completed at that time. Two days later he arrived for physical therapy and reported pain in the shoulder rated at a 1 out of 10, utilizing the same VAS pain rating scale. He successfully completed a round of therapy from 2/4/2020 to 3/13/2020. Pain evaluation at the final therapy visit revealed objective data improvement in range of motion in the shoulder as well as subjective pain score reported at 0-1 out of 10.

His follow-up visit occurred on June 2021; patient reported 90% improvement in not only shoulder pain but also self-reflected PTSD symptoms. He reported at that time he had a lot of family concerns and conflicts that impacted his progress. He reports that he was also recently cleared from the Veteran's affairs psychiatry and only follows with them on a as needed basis. He reported improvement in sleep, no longer suffering from insomnia, and no flashbacks during that time. Additionally, he was weaned off of his prescribed psychiatric medications; sertraline and bupropion hcl.

In July 2021, patient completed his initial WAVi scan. From July 13, 2021, to August 12, 2021 patient completed 10 hours hyperbaric oxygen therapy using the steel Forteius chamber at atmospheric pressures between 1.3-1.75 ATA. The protocol followed was stepwise in nature with 1 session at 1.3 ATA, 2 sessions at 1.5 ATA and 7 sessions at 1.75ATA.

At the end of July 2021 patient received a repeat SGB block for primary PTSD symptoms. The symptoms most prominent at the time of the appointment included repetitive disturbing memories and thoughts, suddenly acting or feeling stressed, heart-poundingly and sweating. At that appointment the PCL-C was completed, and the patient had a score of 33 out of 85. An injection of 2.4 cc neuralgo-rheum and 4 cc 1 % lidocaine under ultrasound guidance to the left middle cervical sympathetic ganglion block was successfully completed. The patient continued with hyperbaric oxygen treatment protocol.

Five days after completing the hyperbaric oxygen protocol a Repeat WAVI scan was done. At that visit he reported that his emotions felt better regulated; there is not as much "activation of high emotions". He did state that he will purposely still avoid certain family situations as to avoid high stress events but for the most part his self-reflected reported status is greatly improved. His PTSD PCL-C score was documented as a 22, with a previously documented score of 33. This was an improvement in 11 points and is considered to be clinically meaningful.

Patient had a scheduled follow up in October of 2021 and at that visit patient reported that he had only one episode of "frustration" and he was able to walk away from that incident without engaging. This particular episode was during a VA meeting. He was able to correlate the trigger to his former stepfather: as the voice, stature and tone of the person was very similar. He also reported other unrelated medical conditions that needed addressed at that time. A repeat PCL-C in October was 29 and he felt that this was due to the stress of his upcoming necessary surgeries. Patient verbalized that he felt that the supportive treatments provided here were "life changing."

Results Review

The improvements due to treatment are quite evident in the WAVi scans; what we clearly see from fig. 1 (voltage map and P300V) is a significant increase in the PTSD-PLC inventory following treatment; first scan patient reports a P300 amplitude of 12.5 uV and after three months this parameter increases to 20.8uV. Fig 2 (spectra) shows a shift in the frontal frequency peak that shifts from 8 to 9.2 Hz and the occipital frequency that shifts from 7 to 10 Hz. Hence, the last scan shows alpha frequency that are more similar to the average values of an age-matched healthy population. One parameter that doesn’t seem to improve is the alpha magnitude that remains constantly lower than average healthy population. Coherence also does not change, and it remains more disconnected than the age matched healthy group, as shown in figure 3.

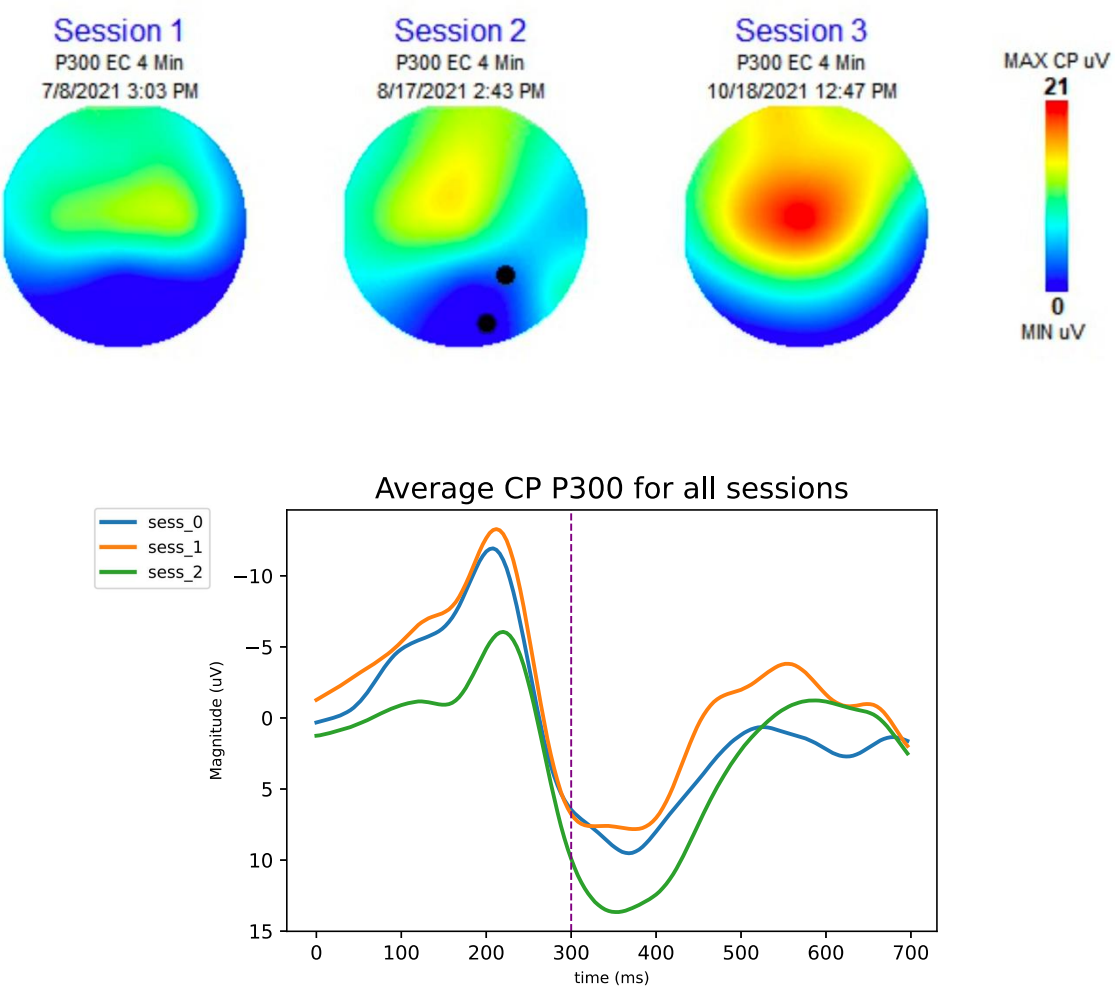

Fig.1. voltage maps for the 3 sessions (top) and central parietal P300 V (bottom) for the 3 different sessions. It is clear that the magnitude of the P300 waveform improves with sessions after stellate ganglion block and HBOT intervention.

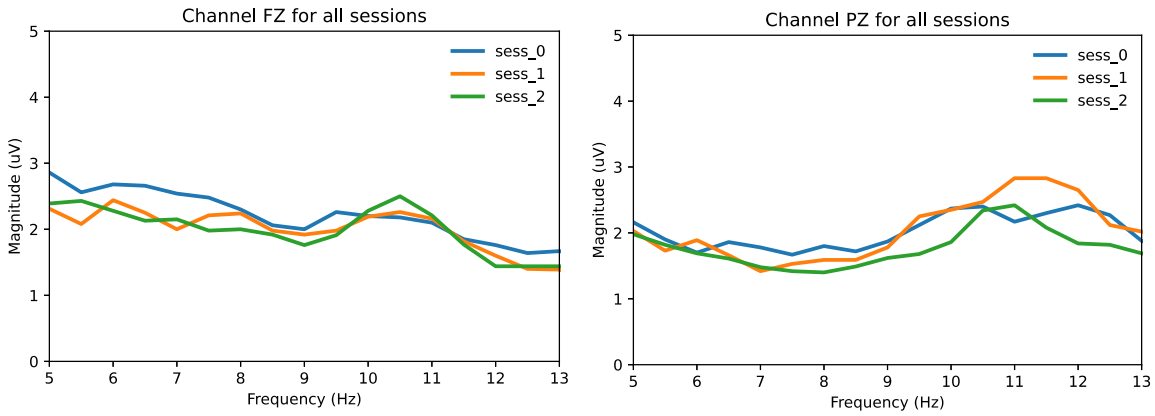

Fig 2. spectra at FZ and PZ for the 3 sessions illustrated in fig.1.

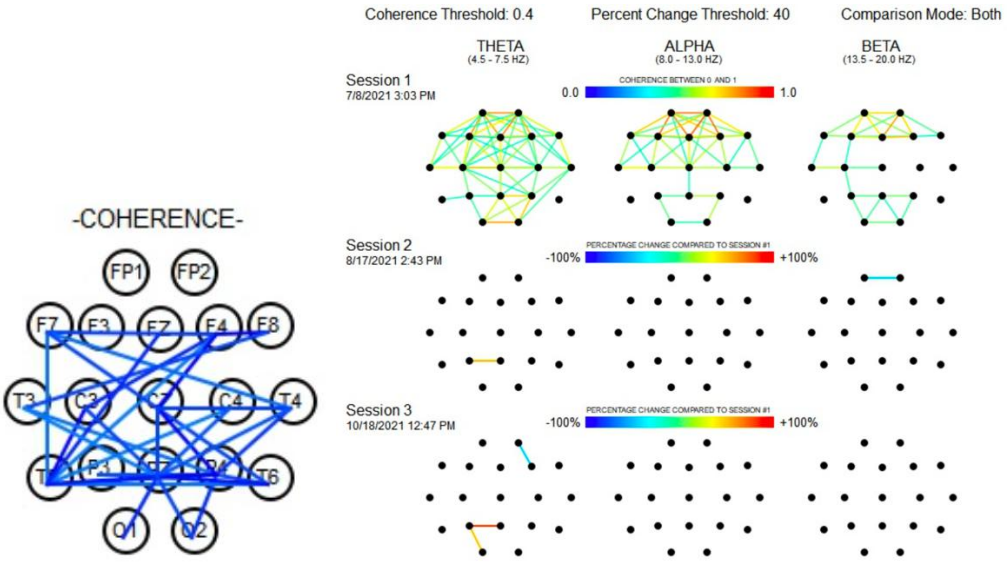

Fig 3. Coherence diagram (left) that shows the links that are 2sigma lower than average. Figure on the right illustrates that there are no changes in following sessions with respect to the first session and hence the coherences are still lower that age matched health population, with patterns consistent to image on the left.

Discussion

It was found that during the treatment protocol that the combination of the SGB and Hyperbaric oxygen treatments that this patient had a successful reduction in PTSD symptoms and improvement in the ability to function within personal relationships. It was clear on the PCL-C that he had a reduction in symptoms at the three-month visit. His PCL-C score went from 33 to 22 out of 85. A reduction in greater than 10 points is considered clinically significant. Even more encouraging is he was able to transition off of his SSRI medication and no longer required ongoing psychiatric appointments. The numbers reflected can be viewed as true improvements due to the intervention. To date he has not had to restart his SSRI medication and has been cleared from psychotherapy so is no longer under active cognitive behavioral therapy. The WAVi scans also indicate increased amplitude and faster P300 suggesting improvement in cognition. Longevity studies would need to be completed to understand the proposed length of time between blocks or specific treatment protocols to generalize to the public.

The mechanism of action of hyperbaric is different than the mechanism of action of a stellate ganglion block. They can both assist in down regulation of the sympathetic nervous system through different pathways. The therapeutic mechanism of action of hyperbaric oxygen

therapy is based on the increase of the partial pressure of inspired O2 and of the hydrostatic pressure (Camporesi & Bosco, 2014). In regard to stellate ganglion blocks, the mechanism of action is proposed to be a direct block to the sympathetic nervous system which has a direct impact on reducing dysfunctional sympathetic tone (Uchida et al., 2002). The complete mechanism of action is not fully understood and is reported as being a complex combination of peripheral vasodilation, reduction in nerve growth factor and brain norepinephrine level (Peterson et al., 2017). Understanding these principles allows for a more comprehensive discussion and treatment of the patient.

Additionally, the approach of understand how each component helps in a complex medical condition, we can posit that the outcome will be achieved more quickly than if these modalities are provided separately. HBOT as a stand-alone treatment can have a positive impact on emotional regulation, cognition and chronic inflammation that leads to pain. Hyperbaric oxygen sessions in this clinic are typically done between 1.3-2.0 ATA for a treatment session of 60 minutes. Patients are on continuous monitoring that assess heartrate and oxygen saturation. The number of treatment sessions varies by diagnosis, however, could follow a 10-, 20-, or 40-hour protocol. This is a very well tolerated protocol for most patients. This clinic routinely obtains objective measure testing before and after an intervention. In this case the objective measures completed were a Wavi scan and serial PCL-C questionnaires. The proposed treatment protocol is delineated below. There is no concrete protocol as each case is unique and different interventions may be appropriate. However, this will lay the foundation for other providers and programs to follow an expected pathway of care.

Proposed Protocol

Intervention	Timeline
New patient evaluation with review of records	Initial visit
PCL-C questionnaire Wavi Scan Hyperbaric Test Dive	Second appointment
Stellate Ganglion block	Third appointment
Completion of HBOT protocol 10-20-40 sessions	5-10-20 weeks twice a week 1.3-1.75 ATA
PCL-C questionnaire	At completion of HBOT series or at the 20 hours and 40 hour session.

Stellate Ganglion block	Minimally 3 months post initial injection if needed
PCL-C questionnaire Wavi Scan	At 3 months or 6 months post initial screen and scan pending HBOT session.

Conclusion

SBG and HBOT is a novel approach for the treatment of a combat veteran that was suffering from PTSD. More studies will be needed to understand the precise mechanisms of action, establish treatment pathways and protocols that are cost effective and safe for the patient. This does not alter the current evidenced based recommended treatment pathway, however; expands upon it for those difficult to treat cases. Hopefully this case study will help to justify the advancement of the research necessary. We would advise more research using double blind randomized control studies, specifically within the PTSD population, to establish an effective standard of care and treatment recommendations for these patients that are suffering or not responding to current treatment management.

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