The Effect of a Single Cranial Electrotherapy Stimulation on Multiple Stress Measures
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Abstract
To assess the post-treatment effects of cranial electrostimulation (CES) on basic psychophysiological measures of stress response, 20 subjects were selected from a clinical treatment population of people seeking help for two common stress problems. 0.5 Hz CES was used for muscle tension with pain and essential hypertension made worse by stress. Because few CES studies utilize the common biofeedback measures of finger temperature, heart rate and trapezius electromyogram, these were selected to be studied before, after, and at one week follow-up from CES. Also measured as a dependent variable was capacitance to assess brain circuit paralleling. All dependent measures were found to change significantly when compared to a placebo group. The author strongly recommends CES researchers use more psychophysiological measures of treatment effects and that some effort be made to understand neuronal path changes resulting from CES.

A large percentage of patient complaints stem from the somatization of patient-perceived or experienced, stress. Stress often produces an alteration in autonomic para-sympathetic, sympathetic balance, resulting in elevations in blood pressure, pulse rate, vasocostriction in peripheral blood vessels, and increased outputs of stress hormone. In the stress response, skeletal muscle tension may rise along with central nervous system shifts toward increased EEG desynchrony, sleep disturbance, reduced brain serotonin, and eventual decline in cognitive performance (Selye, Stephano, Tato, 1969).

Prior work by Zimmerman and Lerner (1989) using cranial electrotherapy (CRS) at 0.5 Hz, random low repetition rate, biphase square wave, demonstrated CES lowered one component of the stress response beyond that achieved by biofeedback. Specifically, the combined use of CES and EMG feedback was demonstrated to produce a synergistic effect in lowering muscle tension levels in chronic pain patients. Other investigations using EMG measures to assess CES on stress arousal are less conclusive. Weingarten (1983) found that 15 CES treatments lowered standardized anxiety scale scores but failed to uniformly lower frontal EMG with biofeedback training. Viewing data from limited studies of autonomic variables shows some support for CES lowering sympathetic arousal. Bretznan (1989), conducting one of the few double blind studies of CES effects on vasomotor tone, found CES to synergize the vasodilatory response produced by biofeedback. The study evaluated treatment effects of CES and/or finger temperature feedback in lowering vasocostriction in a group of migraine patients. Eight sessions of each alone, and combined, demonstrated the greatest significant improvement in the combined use of both CES and biofeedback.
A review of CES literature shows that most double-blind, well-controlled studies look at only one measure of the stress response, often in conjunction with some personality or cognitive psychometric measure. This type of research ignores the obvious clinical reality of symptom substitution and individual physiologic variability in stress responding. Each individual responds differently to stress, and indeed some persons are classified as musculoskeletal responders, whereas others are seen as autonomic responders. Patients are known to often shift the target organ or system under stress at differing times. For this reason, the current study will view the effect of CES simultaneously on two autonomic measures (heart rate, and finger temperature), and on EMG as a musculoskeletal component of stress.

Another shortcoming of current psychophysiology investigations of CES is the failure to assess a single trial treatment effect of CES. The majority of CES studies use several regularly spaced multiple treatments with CES. This study design fails to control for either learned habituation or neural adaptation to the CES as a repetitive simple stimulus. Learned habituation in the physiologically complex nervous system of a human is obvious since this behavioral capability has been established in simple planaria.

Considering the myriad of complex incoming neural signals and the internal complex, chaotic EMG signal, a simple CES signal of little biologic or reinforcement value is a prime candidate for learned habituation. For this reason the current study evaluates a single 30-minute treatment rather than a multitude of repetitive treatments which might in effect be reversing or canceling single treatment effects.

Few CES investigators measure pre- and post-circuit characteristics in the car to our CES circuit. One in-depth investigation of an epileptic patient did confirm electrical parameter changes in the brain during and following CES. A measured decline in resistance was found between electrodes placed by 1 cm. implanted in the posterior to anterior hippocampus following application of CES. This finding shows the importance of circuit monitoring and suggests a resistance drop from
disinhibition or parallel circuiting of neuronal cell assemblies. Given the constant resistance, capacitance product (RC=K), CES would be predicted to increase partial neural gain, and each to cut capacitance. To test this prediction the authors measured capacitance pre- and post-CES while maintaining skin impedance at a constant of 50.

Method

Subjects

Twenty subjects (10) were selected from the author’s private practice. Selection was based on three criteria: 1) persistence of complaint for one year or more, 2) failure of the patient’s condition to respond to medication or other ongoing intervention, and 3) report by the patient that the symptoms were made noticeably worse when the patient was under stress. The patient sample consisted of subjects (90%) with hypertension, and half (50%) with 50% muscle spasm with pain. All 84 consented to participate in the study that was described to facilitate the effects of a microcurrent stimulus on muscle tension, pulse rate, and finger temperature. It was determined to be double-blind. After data collection, the manufacturer released the notes for which unit was active and which was placebo. Six were told the CES treatment used a microcurrent current and they therefore would not feel the CES treatment. Six were asked after all treatments and placebo sessions if they felt any sensations during the session.

Materials

AlphaOmega 106 CES stimulators were purchased from Electromedica Products International Inc., Mineral Wells, Texas. CES stimulation was adjusted to minimal intensity level "1." This level produces about a 100 microamperes, 50 volt-sec, random biphasic square waveform. Pilot studies by the author show this level of intensity is seldom hit by most patients. The placebo and active units were identical in appearance and LCD timer characteristics.

Dependent measures of pulse rate (HR), finger temperature (temp), electromyogram (EMG), and capacitance (aF) were taken in sets of four readings spaced five minutes apart. To give more stable and reliable data these sets of readings were converted into averages. HR was measured by using a standard electronic blood pressure cuff placed over the left brachial artery. Finger temperature was obtained from a one-second response time, feedback monitoring probe placed over the right index finger. EMG was measured by using a scanning surface. EMG made by B&L Electronics placed over the right trapezius muscle at muscle midpoint. Capacitance was measured ear to ear through the CES electrodes by a low current biofeedback capacitance meter set on nano farad (aF) range. The current and voltage parameters of this instrument are very low, making its use on the body safe. CES electrodes were gold-plated, cotton-padded, constant spring tension per dip electrodes. Skin was prepared with non-irritating EG paste prior to electrode placement. Cotton-padded, CES electrodes were kept moist with a saline solution. This procedure insured a constant skin impedance of about 50 ohms.

Both placebo and CES groups were given 30-minute sessions with equal pre- and post-measurement protocols. Both groups were treated identically. After pre- and post-measures were collected, the CES and placebo groups were determined, and a one week follow up of all dependent variables was then performed on the CES group.

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Table 1

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<tr>
<td><strong>Ces &amp; Stress Response</strong></td>
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<td>Pre and Post CES</td>
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<tr>
<td>EMG</td>
<td>2.35</td>
<td>P &lt; .025*</td>
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<tr>
<td>HR</td>
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<td>P &lt; .025*</td>
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<td>Temp</td>
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<td>P &lt; .025*</td>
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<tr>
<td>nF</td>
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<td>Pre and Post Placebo</td>
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Results
An analysis of pre- and post-CES and pre- and post-placebo was performed on each of the dependent variables using the paired t-test. The results of these tests is shown above in Table 1.

None of the Ss reported any sensations being felt at any time during stimulation, in either the CES or placebo group. All Ss in the CES treatment group (Ss 1-10) showed immediate declines in EMG and pulse rates with simultaneous increases in capacitance and finger temperature. These changes were all significant at the .05 level of confidence with confirmation of experimental hypothesis that CES would reduce stress physiologic measures. The results with CES on EMG, HR, and finger temperature were significant at the .05 level. The results in the placebo group (Ss 11-20) showed no such patterns, but rather showed small insignificant fluctuations up and down in all dependent measures. The results by subject are displayed in graphic form, graphs 1-8.

One week follow-up measures in the CES group showed consistent carryover effects in EMG and HR, but were not significant at the .05 level for finger temperature or capacitance.

Discussion
The current study suggests the immediate effects of low level 0.5 Hz, random, 100 microampere currents, delivered to wrists, will be observed in several physiologic functions normally synonymous with stress responding. There are many reasons for
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> the clear and consistent results that the current study produced. The type of CES stimulus used was the nervous system's 50 Hz. This study used a stimulus which is compatible with both frequencies that are associated with parasympathetic response, sleep, and relaxation. Many of the prior studies using this frequency indicate the short-term, elicit stress, and although the literature suggests some relaxation and anti-anxiety effects from 100 Hz, these results may be due to insufficient harmonic distortion of low frequency brainwaves after the treatment ends. This may also explain the reason more treatments are needed to see effects due to inefficient 100 Hz stimulation.

There is another reason involving safety that may contraindicate 100 Hz CES. Some research indicates frequencies above 14 Hz cause cycloretic responses, and consequent efflux of major ions (Becker, 1989). Becker discusses the importance of low frequency, low amangate, direct current stimulation while projecting evidence of the detrimental health effects of 30-100 Hz, HLP. The author has measured and observed EEG spectra during low intensity CES at frequencies, 0.5, 1.5, and 100 Hz. CES at the lower frequency produces an increase in 8-12 Hz EEG amplitudes with an increase in the area under the spectral curve (amplitude x frequency bandwidth) power output. CES at 100 Hz does little to produce these parasympathetic CNS states in the EEG record. Induced during stimulation, 100 Hz may be causing sympathetic response and stress.

Another reason for this study's significant change in EMG, pulse rate, and finger temperature is due to the measurement of incoherency studied CES dependent measures, and selection of proper electrodes. A review of CES literature shows a paucity of studies focusing on psychophysiological measures. This study used standard electrodes with special attention on finger temperature and pulse rates. This oversight is particularly surprising since there is a massive literature on the use of these devices in the biofeedback. EMG in CES studies is often inappropriately studied at uncalibrated recording sites like the forehead and submental muscle. These localities are kill of movement artifact from eye blinking, jaw movement, and are rather small muscle groups often not reflective of total body tension.

The psychophysiological reduction in stress response found in this study may be the probable cause and necessary precondition for noted anxiety reduction found frequency in the CES literature. A meta-analysis by Klawansky, et al. (in press) reveals a positive treatment effect for anxiety when poorly controlled and inadequate sample size CES studies are eliminated. Klawansky's pooling of earlier sample size allows us to make a significant improvement in the use of CES in anxiety management. Prior to personality change there is bound to measures of stress, and only factor in the complex emotion of lowered anxiety. The logical choice of these underling physiological correlates appears to be muscle tension, periperal blood flow, heart rate, and other classical psychophysiological correlates of stress.

Results of the current study suggest that reductions in stress physiology are associated with some basic neural changes in brain tissue. The experience increase found in this study supports an increase in neural and behavioral flexibility that occurs with increasing use and the opening of new parallel neural circuits. The increased flexibility and resistance drop in brain tissue following CES would substantiate the probable basis for cognitive and IQ test improvement often found in CES.

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Bibliography