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Original Article

Changes in Pulse Rate, Respiratory Rate, Blood Oxygenation, Perfusion Index, Skin Conductance, and Their Variability Induced During and After Grounding Human Subjects for 40 Minutes

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Abstract

Objectives: Previous studies have shown that grounding produces quantifiable physiologic changes. We wanted to reproduce and expand on the results obtained in studies reporting on electrophysiologic and physiologic parameters measured immediately after grounding with an improved methodology and state-of-the-art equipment.
Design and subjects: For that purpose, a multiparameter double-blind study was designed and implemented on 14 men and 14 women (age range: 18–80) in relatively good health. Subjects were screened for health problems using a commonly used health questionnaire. They were seated in a comfortable recliner and measured during 2-hour grounding sessions, leaving time for signals to stabilize before, during, and after grounding (40 minutes for each period). Sham 2-hour grounding sessions were also recorded with the same subjects as controls.
Outcome measures: This report presents results for 5 of the 18 parameters measured. The parameters reported here are: skin conductance (SC), blood oxygenation (BO), respiratory rate (RR), pulse rate (PR), and perfusion index (PI).
Settings/location: This study was performed in a rented facility in Encinitas, California. The facility was chosen in a quiet area for its very low electromagnetic noise.
Results: For each session, statistical analyses were performed on four 10-minute segments: before and after grounding (sham grounding for control session) and before and after ungrounding (sham ungrounding). There was an immediate decrease in SC at grounding and an immediate increase at ungrounding on all subjects. RR increased during grounding, and the effect lasted after ungrounding. RR variance increased immediately after grounding then decreased. BO variance decreased during grounding, followed by a dramatic increase after ungrounding. PR and PI variances increased toward the end of the grounding period, and this change persisted after ungrounding.
Conclusions: These results warrant further research to determine how grounding affects the body. Grounding could become important for relaxation, health maintenance and disease prevention.

Introduction

Recent reports have suggested that grounding people might have benefits other than protection against electrocution or protection of electronic components they handle from electrostatic sparks. Benefits reported include improved sleep, normalization of cortisol circadian rhythm, reduced stress,[1] normalization of electrophysiologic measures such as electromyography (EMG) and electroencephalography (EEG), and changes in physiologic parameters such as blood volume pulse (BVP).[2] A comprehensive review of the potential benefits of grounding has been published recently.[3]

This article focuses on 5 of the 18 physiologic or electrophysiologic parameters measured during a multiparameter research project: skin conductance, perfusion index, pulse rate, respiratory rate, and blood oxygenation. The research project was designed to (1) reproduce, with improved methodology and equipment, previously reported physiologic and electrophysiologic results regarding immediate effects during grounding; (2) expand on previous physiologic

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and electrophysiologic studies by measuring more parameters; (3) find out how the body reacts during the first 40 minutes of grounding; and (4) discover what happens to body functions the first 40 minutes after ungrounding. Forty (40)-minute periods were chosen because (1) in pilot projects it was found that signal stabilization can take up to 30 minutes; and (2) a published report including results with thermography equipment showed a marked decrease in chronic inflammation after 30 minutes of grounding.[3]

Based on a hypothetical physiologic model developed from previously published research results and unpublished pilot projects, we hypothesize that (1) skin conductance will decrease immediately after grounding and increase immediately after ungrounding, (2) respiratory rate will increase during grounding and return to pregrounding levels within the 40-minute period after ungrounding, (3) pulse rate will increase during grounding and return to pregrounding levels within the 40-minute period after ungrounding, (4) blood oxygenation will decrease during grounding and come back slowly to before grounding levels within the 40-minute period after ungrounding, and finally (5) the perfusion index will decrease during grounding and return to pregrounding levels within the 40-minute period after ungrounding. The physiologic model assumes that a healing response is activated after 20–30 minutes of grounding. The healing response is carried out through increased metabolic activity, which results in increase oxygen consumption and related increases in pulse rate and respiratory rate and decrease in blood oxygenation. Perfusion index is believed to decrease based on previous results on BVP. During this multiparameter project, we measured BVP with a BVP sensor, also called a photoplethysmograph, as well as with a perfusion index with a state-of-the-art system described in detail below (see section on Recording and Data Processing). The BVP sensor sends infrared light through the skin and measures the amount of reflected light. Since infrared light penetrates a few millimeters under the skin, the amount of light reflected will vary with the amount of blood present in the skin. At each heartbeat (pulse), there is more blood in the skin and more light is reflected. Between pulses, the amount of blood decreases and less light is reflected. The BVP signal is a relative measure, so it does not have a standard unit. On the other hand, the perfusion index is defined as the ratio of the variable portion to the constant portion of reflected light. When we compared the perfusion index recordings with the BVP recordings, we found virtually identical signals.[2]

Materials and Methods

Subjects

The health status of subjects was determined using the Health History Inventory.[4] The results presented in this article are for 28 relatively healthy subjects [48.11 ± 14.48: average age ± standard deviation (SD)]. These subjects were equally divided among men and women: 14 men (45.43 ± 13.62, range 25–66), and 14 women (50.79 ± 15.32, range 26–78). Informed consent was obtained from all subjects prior to their participation. The Biomedical Research Institute of America provided Institutional Review Board supervision of the project (website: www.biomedirb.com).

Exclusion criteria were as follows: (1) pregnancy; (2) age < 18 or over 80; (3) taking pain, anti-inflammatory, sedative, or prescription sleeping medication (less than 5 days prior to testing); (4) taking psychotropic drugs or being diagnosed with mental disorder; (5) recent surgery (less than 1 year); (6) documented life-threatening disease (such as cancer, acquired immune deficiency syndrome, etc.); (7) consumption of alcohol within 48 hours of participation; and (8) use of recreational drugs. Subjects for this study were recruited by word of mouth.

Recording and data processing

To prevent any possibility of electrical ground loops, equipment was chosen that optically isolates subjects from the data acquisition systems. Subjects' pulse rate, perfusion index, and blood oxygenation were recorded using the Radical-7 from Masimo (Masimo Americas, Inc., Irvine, CA, website: www.masimo.com). This state-of-the-art oximeter is based on Masimo SET technology, which uses more than 7 wavelengths of light to acquire blood constituent data based on light absorption. It continuously and noninvasively measures blood oxygenation, pulse rate, perfusion index, hemoglobin, carboxyhemoglobin, and methemoglobin. The probe was placed on the middle finger of the left hand. Trending was set at 2-second resolution for all parameters (the shortest trending window), resulting in a recording rate of 0.5 samples/second (s/s). After each session, data recorded during the session (in the experiment room) were downloaded to a computer located in an adjacent room (the control room) via a USB cable.

Skin conductance and respiratory rate were measured from the ProCom5 Infiniti encoder, a device manufactured by Thought Technology (Thought Technology Ltd., Montreal, Canada; website: www.thoughttechnology.com). This is a five-channel, multimodality device for real-time computerized biofeedback and data acquisition. It has five protected metallic pin sensor inputs with two channels sampled at 2048 s/s (for EEG and EMG) and three channels sampled at 256 s/s. Skin conductance and respiratory rate were sampled at 256 s/s. For skin conductance measurement, the ring finger and little finger of the left hand were used. Respiratory rate was recorded from a respiration sensor that included a sensitive girth sensor using an easy-fitting, high-durability latex rubber band fixed with self-adhering belt worn thoracically over clothing.

For data comparisons, the sampling rate of skin conductance and respiratory rate was reduced to the recording rate of the Masimo device by using one data point per 2 seconds from their recordings. These sensors pass signals to the host computer via a battery-powered, microprocessor-controlled encoder unit. The encoder samples the incoming signals, digitizes, trends (respiratory rate), encodes, and transmits the sampled data to an interface unit designed to send light impulses through a fiberoptic cable (we used a 50-foot cable to send data signals to the host computer in the control room). This transmission system provides maximum freedom of movement, signal fidelity, and electrical isolation.

Grounding system

Four (4) transcutaneous electrical nerve stimulation type adhesive electrode patches were placed on subjects, one on the sole of each foot and one on each palm. Wires from a standard electrostatic discharge ground system were snap-

FIG. 1. Grounding system showing patches, wires, and box connecting to a ground rod planted outside through a switch (not shown) and a fuse (not shown). Similar patches and wires from the hands were also connected to the box to ground the hands.

attached to the electrode patches and connected to a box (Fig. 1). The grounding system itself consisted of a 100-foot-long (30.48 m) ground cord connected to the box on one end and attached to a 12-inch (30.48 cm) stainless steel rod planted in the earth outdoors at the other end. Another box with a switch in between both ends of the grounding cord was used to cut or establish the connection with the earth. The switching box was placed in the control room. The ground cord contained an Underwriters Laboratories–approved 10-mA fuse.

Environmental requirements

To verify that the room was very quiet electrically, a voltmeter with one terminal connected to a separate dedicated ground system (a rod driven into the earth, identical to the body grounding system used in the experiment) was utilized while the wires used to ground subjects were disconnected from the ground rod. The voltmeter had a large (approximately ½-inch diameter) metal contact attached to the ungrounded terminal. Subjects were asked to place their thumb on this contact to measure induced body voltage with respect to the earth. Readings on the body were typically less than 5 mV AC. The voltmeter had an accuracy of ± 0.3%.

Experimental procedure and study design

After a subject's arrival and prior to the first session, the study coordinator verified that the consent form was signed and that all of the subject's questions were answered. Next, she went over the questions of the Health History Inventory for compliance with respect to the exclusion criteria. The subject was then asked to sit in a comfortable reclining chair in the experiment room, electrodes were placed on hands and feet, and the experimental session was started. All recording equipment and the switching box were in the control room, which was adjacent to the experiment room. Only 1 subject was tested per day.

Subjects served as their own controls. Each subject's data from a 2-hour grounded session was compared with another 2-hour session when not grounded (nongrounded or sham-grounded session). The sequence of grounding versus sham grounding sessions was assigned randomly; the only requirement was that 50% of the grounding sessions were the first one. This randomization process was designed to ascertain that the measured effects were due to grounding and not to artifacts produced by sitting in the same position for 2 hours, artifacts due to grounding session order, and/or time of day.

Grounding session order for all subjects was determined prior to the beginning of testing. The same assistant verified every day which session was the grounding session and discretely replaced the fuse with a plastic object (dummy fuse) of the same size before the nongrounded session. This assistant was not permitted any contact with subjects. After a subject was seated in the reclining chair and electrode placement and equipment function was verified, a 40-minute segment was recorded with the switch not flipped. For all sessions (grounded and nongrounded) and for all subjects, the switch was flipped on and off at the same time (40 minutes after the start of the grounding session for the "on" position and 40 minutes later for the "off" position). The assistant in charge of replacing the fuse was the only person during the entire experiment to know which session was the grounding session for each subject. He kept that information confidential until after the last subject was tested. This information was then given to the principal investigator (the author).

The subjects' first session started late morning to early afternoon (start times varied between 10:51 AM and 2:41 PM) and the second session ended late afternoon to early evening (end times varied between 3:18 PM and 7:19 PM). Subjects were not allowed to leave the laboratory premises for the entire experiment, and lunch or a snack was provided (only one exception was allowed).

Movement artifacts were noted from a monitor in the control room connected to a webcam placed in the experiment room. Also, the study coordinator noted any suspect change in monitored parameters from watching the computer screens in real time in the control room. Table 1 shows a summary of the periods in a session. During the first period, the buffering period, subjects and instruments were prepared and tested. During the second (control) period, baseline data were recorded for 40 minutes. At the beginning of the next 40-minute period, the experiment period, the switch was flipped on. At the end of that period, the switch was flipped off. After yet another 40 minutes, the experiment was stopped. This process provided at least 10 minutes of stable data at the end of each period.

Data analysis

To verify our hypotheses and to look for trends in the data, statistical analyses where planned with five purposes in mind: (1) to see whether there are statistically significant differences immediately after grounding as previously reported, (2) to verify any statistically significant change after stabilization of the signals, (3) to discover whether there are any effects after ungrounding, (4) to find out if there are any differences between the grounded sessions compared to the nongrounded sessions, and (5) to determine whether there are any changes in the drift or variability of the physiologic parameters after grounding and ungrounding.

Table 1. The Four Periods of a Session

Instruments	*Preparation*	*Monitoring*	*Monitoring*	*Monitoring*
Period name	Buffering	Control	Experiment	Postexperiment
Switch position	Off	Off	On	Off
Grounding session	~15 minutes	40 minutes	40 minutes	40 minutes
Nongrounding session	~15 minutes	40 minutes	40 minutes	40 minutes

To accomplish the first purpose, each parameter means of the first 10 minutes of the grounded period (E10) were compared with means of the 10-minute period immediately before grounding (C10). For the second purpose, means of the last 10 minutes of the grounding period (E30) were compared with means of the last 10 minutes immediately before grounding (C10). To test for the third purpose, means of the first 10 minutes immediately after ungrounding (U10) were compared with means of the last 10 minutes of the grounded period (E30). These three comparisons were performed using *t* tests for paired samples. For the fourth purpose, means of each period of a grounded session were compared with means of the corresponding period of the nongrounded session. That comparison was done using homoscedastic *t* tests. Even though one-tail *t* tests would have been warranted for our hypotheses, all *t* tests presented here are two-tailed.

Another way to check for the first four purposes is to look at the number of subjects who were lower (or higher) between the two periods tested. This was done using χ^2 tests. For the fifth purpose, variability and slope of the parameters were tested for statistically significant trends. Variability was tested using *t* tests for SDs and drift and/or slope was tested using χ^2 tests. For all tests, the level of statistical significance was set at 0.05.

Results

An example of a grounded session recording for a typical subject is presented in Figure 2. In this example, the subject was grounded at 17:43:00 and ungrounded at 18:23:00. The immediate decrease in skin conductance at grounding and immediate increase at ungrounding are clearly visible. This pattern was observed for all 28 subjects without exception. Figure 3 presents the same parameters during a nongrounded session for the same subject. No abrupt change in skin conductance is visible when the switch was flipped on at 14:05:00 or off at 14:45:00.

T *test results*

The 300 data points per 10 minute segment were averaged and that average was used as one data point for a treatment group. This process was repeated for the 28 subjects giving 28 data points per treatment group. SDs of the 300 data points were also calculated providing 28 data points to test for changes in variance.

Table 2 presents *t* tests performed to test differences in means between pairs of treatment groups. Comparison pairs were (1) within sessions E10–C10, E30–C10, U10–C10, and U10–E30 (degrees of freedom $df = 27$); (2) between sessions (not normalized) C10–C10, E10–E10, E30–E30, and U10–U10 ($df = 54$); (3) between sessions (normalized) E10–E10, E30–E30, and U10–U10 ($df = 54$). In all tables, results ≤ 0.1 were presented because these values may be suggestive for future studies, and sections with no result were omitted for clarity of presentation. The most significant finding in Table 2 is an increase in respiratory rate during E30 and U10 after normalization.

When the difference between only two variances is tested, one can use *F* tests.[7] Since Student's *t* distribution is closely related to Fisher's *F* distribution,[8] one can test the difference between two variances with a *t* test on SDs. The results of those *t* tests are presented in Table 3. The most striking results of this table are an increase in respiratory rate variance just after grounding (E10) and an increase in blood oxygenation variance just after ungrounding. For blood oxygenation, there is also an almost significant increase in variance just after grounding (E10).

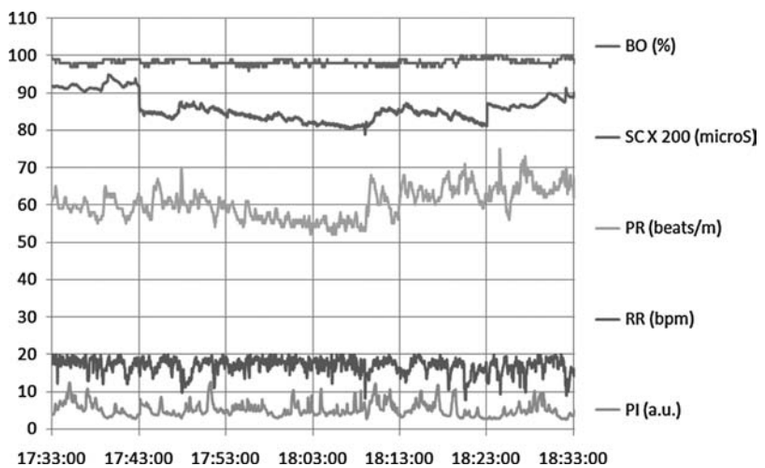

FIG. 2. Typical recording for a grounded session showing a drop in skin conductance (SC) at grounding time (time: 17:43:00) and a jump at ungrounding (time: 18:23:00). SC is in $\mu S \times 200$, perfusion index (PI) in arbitrary units. PR, pulse rate; RR, respiratory rate; BO, blood oxygenation.

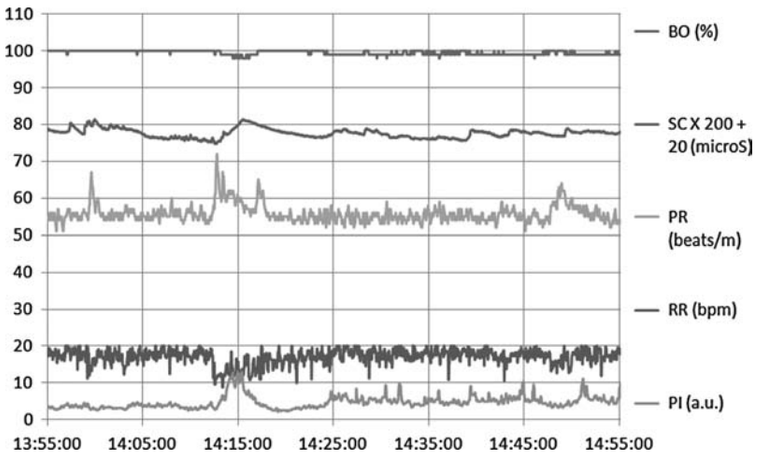

FIG. 3. Typical recording for an ungrounded session. The switch was flipped on at 14:05:00 and off at 14:45:00. BO, blood oxygenation; SC, skin conductance; PR, pulse rate; RR, respiratory rate; PI, perfusion index. ◀AU7

χ^2 tests

Performing a χ^2 test ($df = 1$) on skin conductance recordings with 28 subjects down at grounding and zero subjects up gave a probability of less than 5.0×10^{-7} that this result was due to chance. The same result was obtained when performing a χ^2 test at ungrounding with 28 subjects with skin conductance recordings up and zero down. For the other parameters, χ^2 tests ($df = 2$) were also performed. The only parameter showing a statistically significant result is respiratory rate for the comparison U10–C10 (Table 4, $p = 0.0058$). T4▶

To check for trends in drift/slope, we looked at the slope of the data from the exact grounding time up to 5 minutes after grounding. This process was also applied at ungrounding. If the slope was positive, it was counted up and down if the slope was negative. For most subjects, 2 minutes was enough to find the direction of the slope. In a few cases, the measured slope was unclear or too close to call the first 2 minutes, in which cases the process was expanded to 5 minutes. Table 5 presents χ^2 ($df = 2$) results for blood oxygenation, perfusion index, respiratory rate, and pulse rate using that method. For blood oxygenation, there is a statistically significant number of subjects with a negative slope at ungrounding for the grounded group compared to the nongrounded group ($p = 0.012$). Respiratory rate and pulse rate present a suggestive result at grounding ($p = 0.097$ and $p = 0.10$, respectively), respiratory rate having a greater number of slopes going up while the opposite was true for pulse rate. ◀T5

Discussion and Conclusions

Statistical analyses were designed to reveal whether or not significant changes took place as stated in the five hypotheses presented in the Introduction. Hypothesis 1, that skin

Table 2. *T* Tests for Differences Between Means

	Within sessions			*Between sessions*			
		G	*NG*	*Not norm*		*Norm*	
Parameter	*Periods*	*Probability*	*Probability*	*Period*	*Probability*	*Period*	*Probability*
RR	E10–C10	NS	0.079	C10	NS		
	E30–C10	0.086	NS	E10	NS	E10	NS
	U10–C10	NS	0.095	E30	0.016	E30	0.002
	U10–E30	0.062	NS	U10	0.080	U10	0.018
PR							
PI	E10–C10	NS	NS				
	E30–C10	0.063	NS				
	U10–C10	0.049	NS				
	U10–E30	NS	NS				
BO	E10–C10	NS	NS				
	E30–C10	0.045	0.013				
	U10–C10	0.072	0.040				
	U10–E30	NS	NS				
SC	E10–C10	NS	NS				
	E30–C10	NS	0.018				
	U10–C10	NS	0.012				
	U10–E30	0.044	0.054				

NS, not significant; RR, respiratory rate; PR, pulse rate; PI, perfusion index; BO, blood oxygenation; SC, skin conductance; G, grounded; NG, nongrounded.

Table 3. *T* Tests for Differences in Standard Deviations

	Within sessions			*Between sessions*			
		G	*NG*	*Not norm*		*Norm*	
Parameter	*Periods*	*Probability*	*Probability*	*Period*	*Probability*	*Period*	*Probability*
RR	E10–C10	0.070					
	E30–C10	NS				E10	0.034
	U10–C10	NS				E30	NS
	U10–E30	NS				U10	NS
PR	E10–C10	0.021	0.037				
	E30–C10	0.041	0.003				
	U10–C10	0.002	0.007				
	U10–E30	NS	NS				
PI	E10–C10		0.027	C10	NS		
	E30–C10		NS	E10	NS		
	U10–C10		NS	E30	NS		
	U10–E30		NS	U10	0.083		
BO	E10–C10	0.042		C10	NS		
	E30–C10	0.065		E10	NS	E10	0.056
	U10–C10	0.025		E30	NS	E30	NS
	U10–E30	NS		U10	0.075	U10	0.023
SC	E10–C10		NS				
	E30–C10		NS				
	U10–C10		0.055				
	U10–E30		NS				

NS, not significant; RR, respiratory rate; PR, pulse rate; PI, perfusion index; BO, blood oxygenation; SC, skin conductance; G, grounded; NG, nongrounded.

conductance will decrease immediately after grounding and increase immediately after ungrounding, was verified. Hypothesis 2, that respiratory rate will increase during grounding and return to pregrounding levels within the 40-minute period after ungrounding, was partly verified in that respiratory rate increased during grounding but it did not return to pregrounding levels after ungrounding. Hypothesis 3, that pulse rate will increase during grounding and return to pregrounding levels within the 40-minute period after ungrounding (for the grounded group only), was not verified. Pulse rate increased similarly for both groups during the session (Table 3), indicative of a relaxation effect. Hypothesis 4, that blood oxygenation will decrease during grounding and come back slowly to before grounding levels within the 40-minute period after ungrounding, was not verified. In fact, almost the opposite was observed in that blood oxygenation decreased after ungrounding while blood oxygenation vari-

Table 4. Mean Difference χ^2 Tests for RR

Treat Gs:	*E10–C10*		*Treat Gs:*	*E30–C10*	
Session:	*G*	*NG*	*Session:*	*G*	*NG*
Up	14	12	Up	17	10
Down	14	16	Down	11	18
$\chi^2(2) =$	0.287		$\chi^2(2) =$	3.50	
$p =$	N.S.		$p =$	NS	
Treat Gs:	*U10–C10*		*Treat Gs:*	*U10–E30*	
Session	*G*	*NG*	*Session*	*G*	*NG*
Up	20	8	Up	13	13
Down	8	20	Down	15	15
$\chi^2(2) =$	10.3		$\chi^2(2) =$	0.00	
$p =$	0.0058		$p =$	N.S.	

NS, not significant; Treat Gs, treatment groups; G, grounded; NG, nongrounded.

Table 5. Slope Direction χ^2 Tests for Four Parameters

Para: BO	*At G*		*At U-G*		*Para: PI*	*At G*		*At U-G*	
Session	*G*	*N-G*	*G*	*N-G*	*Session*	*G*	*N-G*	*G*	*N-G*
Up	20	17	6	17	Up	12	11	13	12
Down	8	11	22	11	Down	16	17	15	16
$\chi^2(2) =$	0.717		8.93		$\chi^2(2) =$	0.074		0.072	
$p =$	NS		0.012		$p =$	NS		NS	
Para: RR	*At G*		*At U-G*		*Para: PR*	*At G*		*At U-G*	
Session	*G*	*N-G*	*G*	*N-G*	*Session*	*G*	*N-G*	*G*	*N-G*
Up	20	12	14	17	Up	9	17	15	15
Down	8	16	14	11	Down	19	11	13	13
$\chi^2(2) =$	4.67		0.650		$\chi^2(2) =$	4.59		0.000	
$p =$	0.097		NS		$p =$	0.10		NS	

NS, not significant; Para, parameter; BO, blood oxygenation; PI, perfusion index; G, grounded; U-G,; N-G,; RR, respiratory rate; PR, pulse rate.

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ance increased dramatically for the same period. Hypothesis 5, that perfusion index will decrease during grounding and return to pregrounding levels within the 40-minute period after ungrounding, was also not verified.

Skin conductance abrupt changes at grounding and ungrounding cannot be explained away through ground loop faults since the ProCom5 Infiniti encoder is optically isolated from the data acquisition system. From Figure 2, one can calculate that the skin conductance drop at grounding is on the order of ~40 nanoSiemens (nS). This is about a 10% decrease in skin conductance. From recordings, it is estimated that this drop happens in 0.5–4 seconds, depending on the subject. Skin conductance has long been recognized as a measure of autonomic nervous system (ANS) function,[9] so the conclusion is that grounding produces a rapid change in ANS function. These skin conductance changes suggest that grounding increases parasympathetic system function and/or reduces sympathetic system function. In that regard, the present results support previous studies reporting reduction in stress[2] and improved sleep and relaxation.[1]

Combining observations for blood oxygenation with higher respiratory rate during and after grounding, it seems that the body consumption of oxygen increased during grounding and stayed that way for at least 10 minutes after ungrounding. From that, one can conclude that (1) grounding increases oxygen consumption, necessitating an increase in respiratory rate, (2) ungrounding perturbs a process started during grounding, and (3) this process does not stop at ungrounding but continues for at least 40 minutes after. The decrease in blood oxygenation just after ungrounding even while respiratory rate remains high suggest an even greater consumption of oxygen at ungrounding. It would be interesting to find out how much time it takes for the body to return to the pregrounding respiratory rate and blood oxygenation levels after ungrounding.

The parameters presented in this study relate to the cardiovascular system, the respiratory system, and the autonomic nervous system. The rhythms taking place in these three systems are tied together functionally in the phenomenon known as heart rate variability (HRV). HRV, in turn, is mediated by the autonomic nervous system. HRV appears to be a dynamic marker of both acute and chronic stress produced by mental load, anxiety, or emotional trauma. For example, heart rate does not change significantly with age, but there is a decline in HRV, which has been associated with decreased vagal tone.[10]

The findings presented in this article support previous findings regarding stress reduction and improved sleep.[1,2] This warrants more research to understand first the physiologic and electrophysiologic changes happening during grounding and, on a longer term, the implications and ramifications of grounding for health maintenance and/or disease prevention. This could be an important result that can lead to methods for improving people's health naturally and to cut health care costs by preventing a host of problems and diseases related to stress.

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Disclosure Statement

The author has worked as an independent contractor for Earth FX since 2007 and owns a very small percentage of shares in the company. The author was given free access to the data and entire freedom on data analysis and manuscript writing.

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