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Electrodermal Measurements for Monitoring the Effects of a *Qigong* Workshop

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ABSTRACT

Objectives: Electrodermal measurements with a *Ryodoraku* instrument were used to monitor the effects of a 2-day *qigong* workshop on the body energy of participants.

Methods: Measurements were made of the relative electrical conductivity of 24 acupuncture points on the wrists and feet of 29 subjects. Each subject was measured in the morning and afternoon of each day, and the subjects served as their own control.

Results: The standard deviation of the mean values of the *Ryodoraku* responses of individuals and of the group were less in the afternoons than in the mornings with p-values of 0.004 and 0.0001 for the first and second days, respectively. The decreases in the values of the standard deviations indicate that the balance of the body energy of individuals and the group had improved, presumably as a result of the workshop. We also found that all *Ryodoraku* responses were significantly greater in the afternoons than in the mornings, a result that is attributed to a circadian rhythm.

Conclusions: The improved balance of *qi* energy in the body of the participants indicates that *qigong* practice has the potential to improve health. Electrodermal measurements for monitoring Eastern and Western therapies are discussed.

INTRODUCTION

Electrodermal measurements depend on measuring the electrical conductivity of specific points on the skin (i.e., acupuncture or energy points). There are several hundred such points on the human body. These points generally are located along the meridians that are described by Traditional Chinese Medicine (TCM) theory and that are associated with certain functions of the body. It is generally assumed that the electrical conductivity measurements provide information about the balance of bioenergy or *qi* in the body. These data are usually employed for diagnosis of the condition of the functions of the meridians and their corresponding organs. The diagnosis leads to therapy aiming to correct health problems by improving the flow and uniform distribution of *qi* in the body. Electrodermal screening was described as an indispensable tool for measuring biologic energies that no physician in the 21st century should be without (Moyer, 2002).

According to TCM and *qigong* theory, the *qi* is seen to nourish every cell, every organ and gland, all the tissues. And the *qi* oversees all the systems of the body: digestive, nervous, circulatory, reproductive, cognitive, emotional, etc. The assumption is that *qi* carries the information necessary for the innate intelligence of the body to use the *qi*. An essential aspect of *qi*

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for maintaining health and for healing is that the *qi* should move uniformly and smoothly throughout the body. Another requirement is that the *qi* energy level is appropriately large to carry out its tasks.

In the present study, we used the *Ryodoraku* instrument to make the electrodermal measurements. Nakatani (Nakatani and Yamashita, 1977) developed the Ryodoraku method in 1947, and since that time the instrument has been used widely for diagnosis and therapy, especially in Japan; however, most of the reports are in Japanese. Several books in English describe the theory and practice of the Ryodoraku (Hyodo, 1990; Kenyon, 1985; Nakatani and Yamashita, 1977; Oda, 1989; Yoshida et al., 1999). The Japanese Ryodoraku Society reports research developments in its Japanese journal, in Japanese. The approximate translation of *Ryodoraku* is good (*ryo*), point (*do*), and conductivity (*raku*).

Two recent articles in English describe applications of the *Ryodoraku* instruments for measuring the effects on the body of *qigong* and yoga, which in some respects is related to *qigong*. A study of the effects of three different forms of *qigong* (Yoshida et al., 1999) concluded that the electrical conductivity of the measurement points and the heart rates were found to increase when experienced subjects performed *qigong*, but to decrease or remain unchanged for an inexperienced subject practicing *qigong*. In another study, four kinds of yoga increased grip strength, which was regarded as a good an index of the functioning of the living body (Yoshihuku et al., 1997).

Two other electrodermal techniques have provided information on the energy distribution among the meridians. One technique is Electroacupuncture According to Voll (EAV), which the present author used to show that self-*qigong* practice for about 10 to 15 min helped balance the meridians and organ functions of the body (Sancier 1994). Another technique is the Apparatus for Measuring the Functions of the Meridians and their corresponding organs (AMI). Recently, the AMI was used to study deficient and excess energy patterns in meridian functions in liver disease. (Motoyama Hiroshi, 2000)

One advantage of the *Ryodoraku* and the AMI instruments is that they use wet cotton electrodes to make contact with the skin. However, EAV measurements may disturb the energy balance at the energy point because a metal probe is used and a force on the skin, often required, is occasionally uncomfortable.

INSTRUMENTAL CONSIDERATIONS

For the present study we used the *Ryodoraku* (Neurometer Model D-410, Ryodoraku Research Institute, Tokyo, Japan), a digital readout instrument that was provided by the American College of Traditional Chinese Medicine. The *Ryodoraku* has two electrodes; one is a metal cylinder that is held in one hand of the subject. The other electrode is connected to a spring-loaded probe that contains cotton wet with a biological saline solution and that is applied by the investigator to suitable energy points. The spring-loaded feature ensures that the force applied to the skin is reproducible. Measurements were made at 24 energy points that lay along the 12 principal meridians, according to TCM. Six points are located on each wrist and six are located on each foot. The measurements were made with 12 or 21 Volts D.C., and the current was programmed to increase, with a maximum value of 200 μA. After 0.75 sec the current was automatically interrupted, registered on the digital scale, and then recorded manually.

Nakatani and Yamashita (Nakatani and Yamashita, 1977) developed a nomograph to represent the differences of the electrical conductivities of the twelve meridians of many healthy people. The present author is neither aware of reports on these measurements nor of any scientific studies to verify the two researchers' observations, a subject for further research. Using the nomograph requires calculating the average of all current readings from all 24 points on the hands and feet and then manually measuring the distance (e.g., cm) of each current reading from the average. This procedure compensates for the differences in the conductivities of the meridians. To avoid the cumbersome nomograph, Oda (1989) developed an algorithm that takes into account the differences in conductivity of the meridians and converts the measured current values to a distance from the average value:

$$N(k,x) = 8.29 \log (0.0856 + 0.0228\, kx),$$

TABLE 1. FUNCTION ASSOCIATED WITH EACH MERIDIAN, CORRESPONDING *k*-VALUE ASSOCIATED DESIGNATION OF *RYODORAKU* POINTS, AND TCM MEASURING POINTS

Meridians	k-*value*	Ryo *points*	*TCM points*
Lung	0.83	H1	LU 9
Heart constrictor	0.093	H2	HC 7
Heart	1.08	H3	HT 7
Small intestines	0.091	H4	SI 5
Triple heater	0.80	H5	TH 4
Large intestines	0.80	H6	LI 5
Spleen	0.98	F1	SP 3
Liver	1.21	F2	LV 3
Kidney	0.98	F3	KI 4
Bladder	1.05	F4	BL 65
Gall bladder	1.21	F5	GB 40
Stomach	1.11	F6	ST 42

TCM, Traditional Chinese Medicine.

when N is a distance in centimeters from the average of all 24 readings, k is a constant representing the relative conductivity of a given meridian, and x is the measured current. Using a computer, we used this equation to convert the measured current readings to response values in centimeters. The values of k for each of the 12 main meridians reported by Nakatani are listed in Table 1 along with the symbol for the Ryodoraku measurement points. Points on the wrists are indicated by H1 . . . H6, and points on the feet by F1 . . . F6. The location of these points on the hands and feet are shown in Fig. 1. Nakatani reports a more detailed description of the location of these points.

For diagnostic purposes, Nakatani defined a physiologic acceptable range for health as a band 40 μA wide and centered about the average value of all current values. The bandwidth of 40 μA was obtained from measurements of many healthy subjects. Readings below this band indicate deficient *qi* energy and readings above indicate excess *qi* energy of the corresponding organ. Nakatani developed a *Ryodoraku* symptom chart for diagnosis; however, diagnosis was not part of the present study. Using Oda's algorithm the acceptable physiologic range is a band 1.4 cm wide, which is drawn central to the average value of all points. Points within this band are considered to be in an acceptable physiologic range, and points outside the band indicate an imbalance in the corresponding organ. The acceptable physiologic range is illustrated for subject #12 by the dashed lines in Fig. 2 that shows the measured responses of one subject at four different measurement times. Note that each physiologic range is based on the average of all 24 readings taken for the subject at a given time.

METHODOLOGY

A 2-day *qigong* workshop was held at the Land of Medicine Buddha in a rural setting in Soquel, California, at which the students were housed and fed. The workshop was one of the regular bimonthly series given by Bingkun Hu, Ph.D., a psychologist and a well-respected *qigong* master and *qigong* teacher. The workshop was held on Saturday from 9 AM to 5 PM, and on Sunday from 9 AM to 4 PM. Dr. Hu introduced the class to microcosmic and macrocosmic orbit *qigong* that required movements of the body to help circulate the *qi*. During the practice the students were encouraged to be aware of movement of *qi* in their bodies. The subjects practiced *qigong* approximately 5 h each day. For this study the subjects served as their own controls, so that the results focused on measured changes in individuals and in the group.

Of the 35 subjects who registered for the workshop, 29 subjects completed the requirements and their results are included in this study. Most had previously studied *qigong* or yoga, and several were regular students of Dr. Hu. There were 6 men and 23 women and their ages ranged from 23 to 79 (average 49.0 ± 12.8). The subjects were advised that they would be tested four times dur-

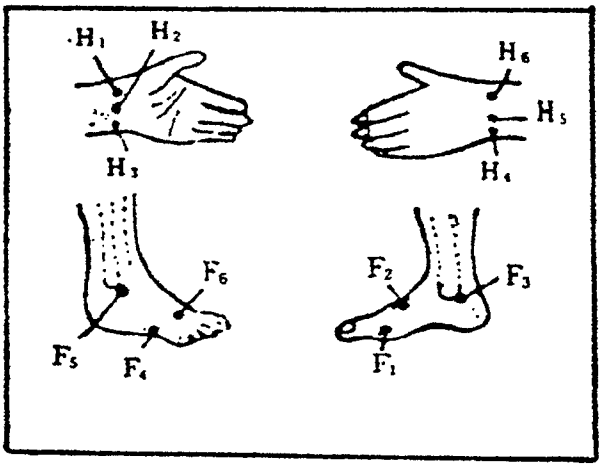

FIG. 1. *Ryodoraku* measuring points on the hands and feet.

ing the workshop to measure changes in body energy, on Saturday and Sunday in the mornings (7 to 9 AM) and the afternoons (4 to 6 PM), that is, before and after the instruction. The teacher was not present during the measurements so not to influence the subjects.

RESULTS AND DISCUSSION

Group results

For each of the four measurement times, the average *Ryodoraku* responses of each of the 29 subjects are shown in Table 2. The average responses and the standard deviations from the average of the group are given in the bottom section of the table. For most subjects and for the group the averages are greater and the standard deviations from the average are smaller in the afternoons than the mornings of both days.

Using statistical analysis by the Sign Test (Khazanie, 1990), we obtained the number of subjects whose average responses were greater than the group average, that is, positive, as shown in the bottom section of Table 2. The sign test determines whether the number of positive responses were the same as by chance, namely 50% of 29 subjects. If they were significantly greater than 50%, our null hypothesis would be that $p = 50\%$ versus our alternate that $p > 50\%$. The p-values were calculated using a binomial distribution.

The number of positive responses for the group for the afternoons of Saturday and Sunday were 27 and 29, leading to p-values of $p < 0.00001$ and <0.00001, respectively. For the morning measurements on Saturday and Sunday, the number of positive responses were 14 and 11, leading to p-values of 0.64 and 0.93, respectively.

The standard deviations in the afternoons were smaller in the afternoons than in the mornings (bottom of Table 2). This result suggests that the body functions of the group were better balanced in the afternoons than in the mornings.

The effect of time interval (Sat. AM to Sat. PM, Sun. AM to Sun. PM, etc.) between measurements on the values of the standard deviations for all subjects was obtained from the data in Table 2 by counting the number of decreases in the standard deviations for given time intervals. A decrease in standard deviations of an individual or the group suggests an improved balance of body energy. The results are summarized in Table 3, where largest numbers of decreases oc-

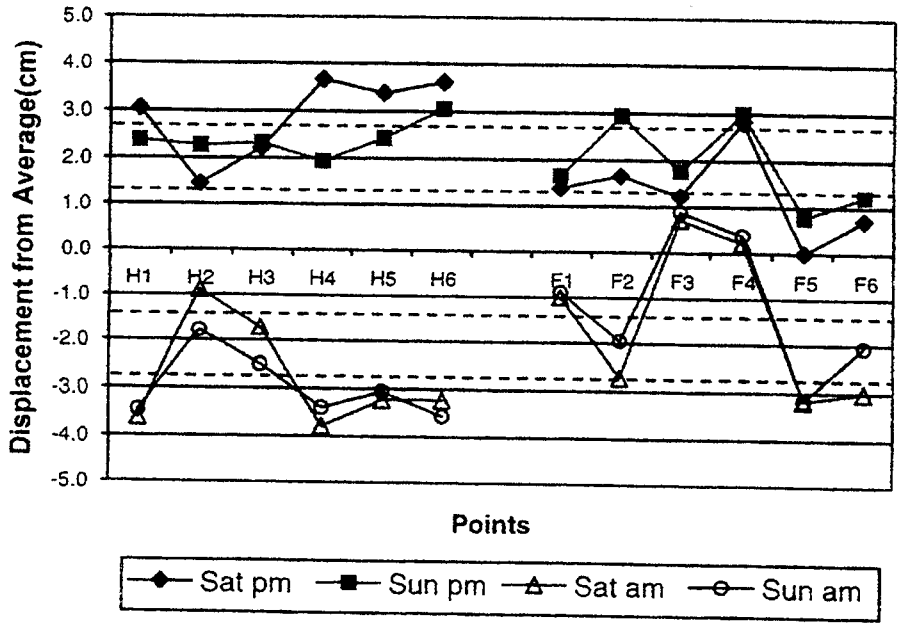

FIG. 2. The *Ryodoraku* displacements of the responses from the average of all readings for subject #12 as measured on four occasions during the workshop. For the above figure, only the values from the right hand and feet were averaged. Pairs of horizontal dashed lines define the acceptable physiologic range; one pair centered around the average value of 2.2 cm for the afternoon readings and the other approximately −0.21 cm for the morning readings.

TABLE 2. SUMMARY OF *RYODORAKU* RESPONSES (CM) AND STATISTICAL ANALYSIS FOR THE 29 SUBJECTS DURING THE WEEKEND QIGONG WORKSHOP

Subject #	*Response (cm)*			
	Sat AM	*Sat PM*	*Sun AM*	*Sun PM*
1	0.61	3.64	2.59	3.74
2	1.51	0.22	−1.25	1.86
3	−1.69	0.24	−1.57	0.20
4	−2.18	1.37	0.89	2.07
5	−1.15	1.20	−0.18	0.17
6	−1.38	−0.14	−2.86	0.76
7	−0.15	1.05	−1.23	1.47
8	−0.36	1.57	−0.59	0.39
9	−1.73	2.23	−0.67	0.76
10	0.22	0.25	1.71	2.21
11	2.43	1.16	−0.32	1.36
12	−2.25	1.79	−2.41	2.07
13	1.58	2.69	1.03	2.71
14	−0.90	1.79	0.78	1.76
15	−2.07	1.12	0.48	1.24
16	0.13	2.06	2.24	2.47
17	−2.25	0.58	−2.59	0.00
18	0.30	2.73	0.93	2.56
19	−0.39	1.59	−0.82	1.42
20	−1.55	−1.06	−0.54	1.05
21	0.49	1.12	−2.25	0.57
22	−0.12	2.12	0.97	0.88
23	1.06	2.48	0.54	3.12
24	−3.22	2.83	−4.42	3.05
25	0.02	0.55	−0.11	1.26
26	1.59	0.32	−0.20	2.17
27	0.04	0.81	−1.60	1.15
28	0.69	2.12	0.38	1.78
29	0.70	1.32	−0.37	1.04
Average response	−0.34	1.37	−0.39	1.56
Standard deviation	1.40	1.03	1.59	0.95
# positives	14	27	11	29
p-value for positives	0.64	<0.000001	0.93	<0.000001

The responses for each subject for a given measurement time are an average of readings from the right and left sides of the body. A total of 35 subjects enlisted in the study, but 29 completed the course.

curred over the period of the entire period of the workshop (26 with $p < 0.00001$). The second largest occurred during Sunday (22 with $p < 0.004$). According to these data, the energy balance improved during the 2-day workshop in 26 out of the 29 subjects. Appreciable balancing occurred just during the last day (22 out of the 29 subjects). However, no appreciable balancing occurred either during the first day of the workshop or over night from Saturday to Sunday (*p*-values of 0.13 and 0.64, respectively).

Single case

Typical Ryodoraku responses for one subject, #12, are illustrated by the data in Table 4 and plotted in Fig. 2. For simplicity in calculation and plotting, the data include only those from the right side of the body. In Fig. 2, the two pairs of dashed horizontal lines define the acceptable physiologic range, which is a band 1.4 cm wide centered at the average of all readings for a given measurement time.

The most obvious feature of Fig. 2 is that the responses were much greater (more positive) in the afternoons (top curves) than in the mornings (bottom curves) on both days. To the author's knowledge, such an effect has not been reported previously. Another visually discernable feature is that variations of the measurements were smaller during the afternoons (top curves) than during the mornings (bottom curves). This *latter* observation is confirmed by the lower values of the standard deviations in the afternoons of both days in Table 4. This behavior suggests that there

TABLE 3. NUMBER OF DECREASES IN STANDARD DEVIATIONS OF *RYODORAKU* RESPONSES OF ALL 29 SUBJECTS DEPENDING ON INTERVAL OF TIME OF MEASUREMENTS AND *p*-VALUE OBTAINED USING THE SIGN TEST

	Sat AM to PM	*Sun AM to PM*	*Sat PM to Sun AM*	*Sat AM to Sun PM*
Number of decreased standard deviations via Sign Test	18	22	14	26
P-value of standard deviation	0.13	<0.004	0.64	<0.00001

was a factor that contributed to better balance among the meridians in the afternoons. The results obtained for subject #12 are qualitatively in accord with those of the group.

CONCLUSION

The 2-day *qigong* workshop resulted in two statistically significant changes in the electrodermal measurements of the subjects as measured by the *Ryodoraku* instrument: (1) The decrease of standard deviations (deions) of the responses of individual subjects and the group during the workshop suggests that the workshop had improved *qi* energy balance. A decreasing value of the standard deviation of the *Ryodoraku* responses indicates an improved balance of the energies of the meridian systems. For complete energy balance among the meridians the standard deviations from the average would ideally be 0. It follows according to TCM theory the electrodermal measurements support the concept that *qigong* practice improves the health of the practitioners. (2) The effects of circadian rhythm can explain the larger average responses of the group in the afternoons of both days compared with the mornings. Humans are active and the sympathetic nervous system is dominant in the daytime, whereas, humans are less active in the evening when the parasympathetic nervous system is dominant. Supporting this dependence is a report that in healthy persons the serum levels of the stimulating hormones adrenaline and nor-adrenaline follow the circadian rhythm, being high during the day and low at night (Abo, 2002).

An improvement in *qi* energy balance is the ultimate objective of *qigong* and TCM to improve health and healing. However, *qigong* can be learned and practiced by an individual, whereas Chinese medicine therapies, such as acupuncture, herbal therapy and massage, require trained and licensed TCM therapists.

There are several confounding factors that we could not study. For example, perspiration

TABLE 4. DEPENDENCE OF INDIVIDUAL *RYODORAKU* RESPONSES (CM) OF SUBJECT #12 DEPENDING ON MEASUREMENT TIMES

Ryodoraku *points*	k-*Value*	*Sat AM*	*Sat PM*	*Sun AM*	*Sun PM*
H1	0.83	−3.6	3.1	−3.4	2.4
H2	0.93	−0.9	1.4	−1.8	2.3
H3	1.08	−1.7	2.2	−2.5	2.3
H4	0.91	−3.8	3.6	−3.4	1.9
H5	0.80	−3.2	3.4	−3.1	2.4
H6	0.80	−3.2	3.6	−3.6	3.1
F1	0.98	−1.0	1.4	−0.9	1.7
F2	1.21	−2.7	1.7	−2.0	2.9
F3	0.98	0.7	1.2	0.9	1.8
F4	1.05	0.2	2.9	0.4	3.0
F5	1.21	−3.2	0.0	−3.2	0.8
F6	1.11	−3.0	0.7	−2.1	1.2
Average		−2.1	2.1	−2.0	2.2
Standard deviation		1.55	1.20	1.49	0.70

Responses were taken from measurements at points only on the right side of the body.

tends to increase the electrical conductivity of the skin, which in turn would tend to increase the *Ryodoraku* response. This effect could occur even though the measurements were made with a wet probe. Another uncontrolled factor is the potential relaxing effect of being among friends in rural environment where the workshop was held. Establishing a control group of healthy subjects was not feasible because limited funding and the difficulty in identifying a suitable group. This remains an area for further study.

While diagnosis was not part of the present study, the electrodermal technique is presently used in Japan for diagnosis and therapy. To test the diagnostic ability of the Ryodoraku, a pilot study using the Ryodoraku was initiated at the American College of Traditional Chinese Medicine. These unpublished results showed that diagnosis by the *Ryodoraku* was in substantial agreement with that of TCM and the patient's complaint, and the *Ryodoraku* reflected the beneficial effects of TCM therapy.

Because Nakatani has reported electrodermal measurements to diagnosis health problems, this technique can probably be used to monitor the course of different therapies. For example, it might be possible to determine the relative benefits of different forms of *qigong* and to evaluate the outcome of medical *qigong* therapy, either by self-practice or by treatment by a *qigong* master. Electrodermal monitoring could possibly also be applied to evaluate some alternative & complementary medical therapies, such as acupuncture, Reiki, yoga, *tai* chi, biofeedback, mediation of different kinds, herbs, nutritional supplements, foods, and physical exercise of different kinds. Electrodermal measurements could probably be used to evaluate the outcome of traditional Western medicine, including surgery and drugs. Such measurements also may provide a comparative basis for evaluating the relative benefits of Eastern and Western therapies. The electrodermal approach has the potential to provide a basis for a customized treatment plan for each individual.

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