ORIGINAL RESEARCH ARTICLE

Evid Based Integrative Med 2005; 2 (4): 245-252
1176-2330/05/0004-0245/$34.95/0

Digital High-Voltage Electrophotographic Measures of the Fingertips of Subjects Pre- and Post-Qigong

Beverly Rubik[1,2] and *Audrey J. Brooks*[3,4]

1 Institute for Frontier Science, Oakland, California, USA
2 Union Institute and University, Cincinnati, Ohio, USA
3 Department of Psychology, University of Arizona, Tucson, Arizona, USA
4 Center for Frontier Medicine in Biofield Science, University of Arizona, Tucson, Arizona, USA

Abstract

Objective: The purpose of this study is to explore how performing qigong influences certain measurable aspects of the human biofield; namely, various calculated parameters of finger corona discharge patterns produced by high-voltage electrophotography.

Methods: The Gas Discharge Visualization (GDV) camera was used to assess subjects before and after performing Dayan (wild goose) qigong in workshop settings. Sixteen adults (48–80 years old), seven diagnosed with chronic disease, were studied. Subjects ranged from qigong novices to those having had 8 years of practice. Measurements were made on all ten fingertips of 16 subjects pre- and post-qigong. The patterns of light emitted from the subjects' fingertips were digitally recorded and computer analysed. Parameters including normalised area, brightness, density, fractality form coefficient, fractality dimension, and right- and left-hand integrals were calculated and statistically compared.

Results: The uniformity of the density of the circles of light emitted from the fingertips increased post-qigong. A trend was observed for the variability in the fractal form coefficient to decrease post-qigong. Subjects with chronic health problems increased in fractal dimension post-qigong, while those without health problems showed a decrease. There was a trend for the light emitted by the fingertips of qigong-experienced subjects to decrease in brightness, whereas inexperienced subjects had increased brightness. The right integral increased post-qigong in experienced subjects, whereas the left integral increased in inexperienced subjects.

Conclusions: Qigong practice influenced some of the GDV parameters of the finger emission patterns significantly but the data supported only some of our hypotheses. The GDV technique may be a valuable tool in assessing changes in parameters of the human biofield both clinically and in investigating mechanisms of action of complementary and alternative medicine interventions.

Qigong refers to cultivation or mastery of qi through consistent practice, which originated in China in the 26th century B.C. It involves gathering qi (universal life energy), i.e. bringing qi from sky and earth into one's body, and distributing it via mindful intention, breath and sometimes by means of movement. One of the pillars of traditional Chinese medicine (TCM), qigong practice can purportedly regulate the mind-body. Inner qigong focuses on breath and consciousness, whereas external qigong focuses more on posture and movement. There are numerous health claims concerning qigong, which are supported by a small but growing body of research.[1] Positive benefits from qigong have been found for hypertension,[2,3] asthma,[4] cancer,[3,5] diabetes mellitus,[6] pain,[7] drug addiction,[8] increased sex hormone levels in the elderly[9] and biopsychosocial health in the elderly.[10] Studies

addressing the mechanism of action of qigong have shown changes in electrodermal measurements,[11,12] electromyographic activity,[13] stress hormones[14] and brain function using modern neuromonitoring tools.[15]

Thousands of forms of qigong abound today. Dayan qigong (wild goose form) is an ancient form of external and internal qigong that imitates the form and movements of the wild goose in nature while breathing naturally. It originated in a monastery in the Kunlun Mountains in the west of China. Recorded by Taoist monks during the Qin Dynasty approximately 1700 years ago, it was dutifully passed down by masters over the centuries. The most recent Chinese master known in the West was Yang Maijun, a female, the 27th-generation lineage holder and qigong grandmaster, who died in 2002 at 107 years of age. Dayan qigong is one of the most highly regarded qigongs for health and is widely practiced throughout the world today. It said to combat fatigue, maintain physical fitness, cure and prevent disease, improve health, delay aging and lengthen life. Because of this, it is also considered a form of medical qigong. The first set of 64 moves is the basic form studied here.[16]

According to TCM, the smooth, unimpeded flow of qi is essential to vitality and health. One of the main premises of TCM and medical qigong practice is that where the mind goes, qi flows, and blood follows qi. That is, the mind is the master of qi, which, in turn, once moved, can move the blood and heal the flesh.

To test this premise, we conducted this initial study to measure the energy emitted from healthy and chronically ill subjects undertaking qigong practice, to observe any difference before and after qigong. Measurement of the emitted energy also offers a window into the biofield of the organism, which has been hypothesised to regulate homeodynamics of biochemical and physiological processes and promote health and healing.[17] The induced light emitted from the fingertips of subjects practicing Dayan qigong in workshop settings was measured using digital high-voltage electrophotography.

The purpose of the present study was to compare measurements made with a Gas Discharge Visualization (GDV) camera before and after a qigong session. We hypothesised that the following would be observed.

1. Post-qigong emission patterns would be larger in area because qigong would enhance the flow of qi through the body.

2. The duration of prior qigong experience would be associated with larger changes in emission patterns.

3. The presence of a chronic health problem would be associated with larger changes in emission patterns.

4. The comparison of right- and left-hand emission patterns, which relate to the relative distribution of energy in the right and left sides of the body, would be more uniform post-qigong.

Because of the exploratory nature of the present study, other parameters of the digital electrophotographs in addition to area, including density, brightness, fractal form coefficient and fractal dimension, were also analysed. This was done to observe any trends or possible significant differences that might correlate with the qigong intervention, health status and/or subject experience.

Materials and Methods

Research Design

We conducted a field experiment at two different qigong workshops in San Francisco, CA, USA, convened on 4 May 2001 and 4 November 2002 in the same hotel meeting room, during the Fourth and Fifth World Qigong Congresses hosted by Effie Chow, PhD. The qigong instructor for both workshops was Bett Lujan Martinez, who has 8 years of experience in Dayan qigong and claims to have been cured of autoimmune chronic active hepatitis by means of TCM, including intense qigong practice. Digital electrophotographs of all ten fingertips of the subjects were made immediately before the warmup exercises (adapted from the Shaolin martial arts lineage), which preceded the sequence of 64 moves of Dayan Qigong, and again after subjects had completed the sequence.

Human Subjects

There were no subject inclusion or exclusion criteria; all subjects (n = 17) who participated in the two Dayan qigong workshops were freely enrolled. All but two of the subjects were women. One subject was eliminated from the analysis as a result of observed data inconsistencies in addition to uncertainty with respect to her prior qigong experience. The mean age of the subjects (n = 16) was 62.1 years, the standard deviation (SD) was 9.1 years, and the range was from 48 to 80 years. Seven of the subjects had a chronic health problem. Problems included multiple sclerosis, kidney failure requiring dialysis, Parkinson's disease, osteoarthritis, diabetes with associated neuropathies, pain syndrome associated with a dysfunctional hip joint replacement and primary biliary sclerosis. The subjects ranged from novices with no previous qigong experience to experienced subjects with 8 years of practice. The average duration of practice was just under 2 years (mean 23.8 months, SD 33.8). Nine subjects had ≤4 months' experience, while

the other seven subjects had a range of 1.5–8 years of qigong practice.

Different subjects participated in each workshop, and the data from both workshops were pooled for analysis. In this study, the researchers were not blinded as to any aspect of subject information, including their name, age, health status and qigong experience. Subjects were selected in random order for the initial ten-finger measurements before qigong. This same subject order was retained in the post-qigong measurement to standardise the time between the measurements for each subject, which was about 2 hours from pre- to post-qigong. Because of time constraints, subjects were measured only once pre- and post-qigong. There was no control group in the study; each subject served as their own control in the pre-qigong condition.

Measurement Protocol

The instrument used to measure subjects is the GDV Camera (Dr. Korotov Co., Lappeenranta, Finland; www.korotov.org), which images corona discharges at the fingertips induced by a pulsed electrical signal (10–15kV, 1024Hz, 10-microsecond pulses) on the glass plate of the camera. This device produces a type of digital high-voltage electrophotography that is based on the Kirlian effect.[18] A charge-coupled detector (CCD) detects the pattern of photons (visible and near-UV) arriving over time, and data is sent by cable to a computer for analysis. The GDV Camera has associated software programs to assess various parameters of the light emission patterns, including area, intensity, density and fractality, as well as details of various sectors of the fingertip patterns that purportedly relate to the bioenergetics of specific organs and organ systems.[19] The standardisation of techniques to show the stability and reproducibility of the GDV parameters has been described by the inventor.[20] Other researchers have used similar high-voltage electrophotography to investigate reproducibility of assessment of biofield practitioners and controls with significant results.[21]

The GDV Camera has been used for clinical studies mainly in Russia,[22] where it is a registered medical device. It has also been used to monitor the results of stress management training.[23] Indeed, studies by researchers worldwide are currently underway, which explore the camera's utility for biologic systems ranging from biofield assessment of human subjects[24] to studying homeopathic remedies.[25]

All ten fingertips of the subjects were measured, one finger at a time, in the following order: from left thumb to left little finger, and from right thumb to right little finger. The time exposure of each fingertip to the signal on the electrified glass plate was 1 second. The static digital photos of the GDV-grams (light emission patterns from each fingertip) were captured as bitmap files on a computer.

Results

Gas Discharge Visualization-Grams and Calculated Parameters

Examples of the data gathered from a single subject are shown in figure 1 and figure 2. The GDV-grams obtained from measuring all ten fingertips of a healthy subject with 5 years of qigong practice before performing qigong is shown in figure 1. Fingers are labelled as either right (R) or left (L) and numbered from 1 to 5 – the thumb is indicated by '1' and the little finger is indicated by '5'. Figure 2 shows the data from the same subject post-qigong. The GDV-grams for this subject post-qigong are noticeably larger in size or area and more regular in shape than the pre-qigong data.

For each of the GDV-grams of all subjects, the following parameters were calculated:

- Total area (S): defined as the number of pixels (digital picture elements) that constitute the region where light is detected, i.e. registered as being brighter than the background threshold value.
- Normalised area: the ratio of the image of the glow area to the total area of the region that includes the image, effectively removing the influence of the inner oval due to the fingerprint size.
- Average brightness: the average of the intensity of light at every illuminated pixel divided by the number of pixels.
- Total density (D): the ratio of the image glow area to the total area of the region that includes the image (D = 1 for a solid circle).
- Fractality form coefficient: $(FC) = c\sqrt{L^2/S}$, where L is the length of the GDV-gram external contour, S is the GDV-gram total area and c is a constant.
- Fractality dimension (FD): ratio of lengths of perimeters of the image glow, obtained in different scales of the GDV-gram. FC and FD show the degree of irregularity of the GDV-gram external contour: the smaller the FC, the smoother the external contour of the GDV-gram.

A parameter that is derived from all ten of the GDV-grams corresponding to the ten fingertips is the integral area coefficient (JS). This is based on fractional sector analysis in polar coordi-

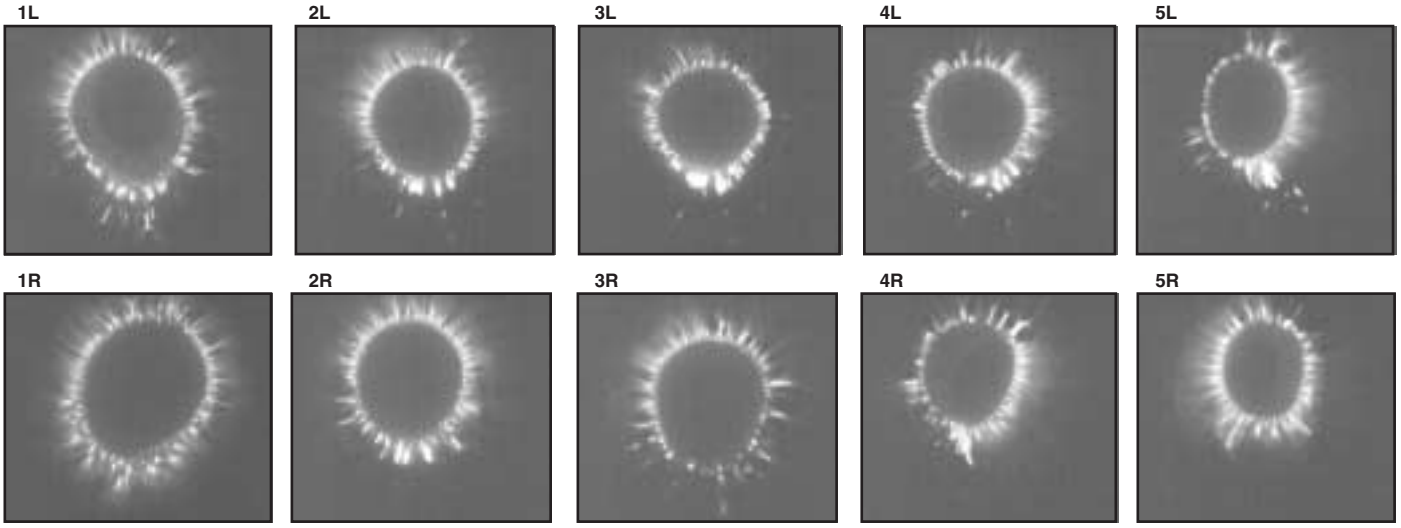

Fig. 1. Gas Discharge Visualization (GDV)-grams of all ten fingers of a subject, pre-qigong. Fingers are labelled L (left) or R (right), and numbered sequentially from 1 to 5, with 1 indicating the thumb, and 5 indicating the little finger.

nates from 0° to 360° of the GDV-grams of the right and left hands, respectively, and integrated to yield a measure of the relative energy field distribution in the right and left hands. The parameters are mathematically defined elsewhere.[26] The mean values and the standard deviations of all parameters for each subject as well as for various groupings of subjects, including the whole group, were computed from calculated parameters for each subject. These data were analysed for statistical significance.

Statistical Analysis

All analyses were conducted using SPSS® 11.0. The average rating over the ten fingers was used for each of the GDV variables. Paired t-tests were conducted to examine pre- and post-qigong changes in the normalised area, brightness, density, fractality form coefficient, fractality dimension and integral symmetry. Integral symmetry was determined by creating a difference score, subtracting the left-hand integral from the right-hand integral scores. Values close to zero indicate symmetry of energy field distribution between the right and left hands and presumably between the right and left sides of the body. The standard deviation from the average of the ten figures was also used as a dependent variable. The purpose of this was to examine any changes in the variability between the fingers pre- to post-qigong. To examine the role of length of practice, the sample was divided into subjects with zero

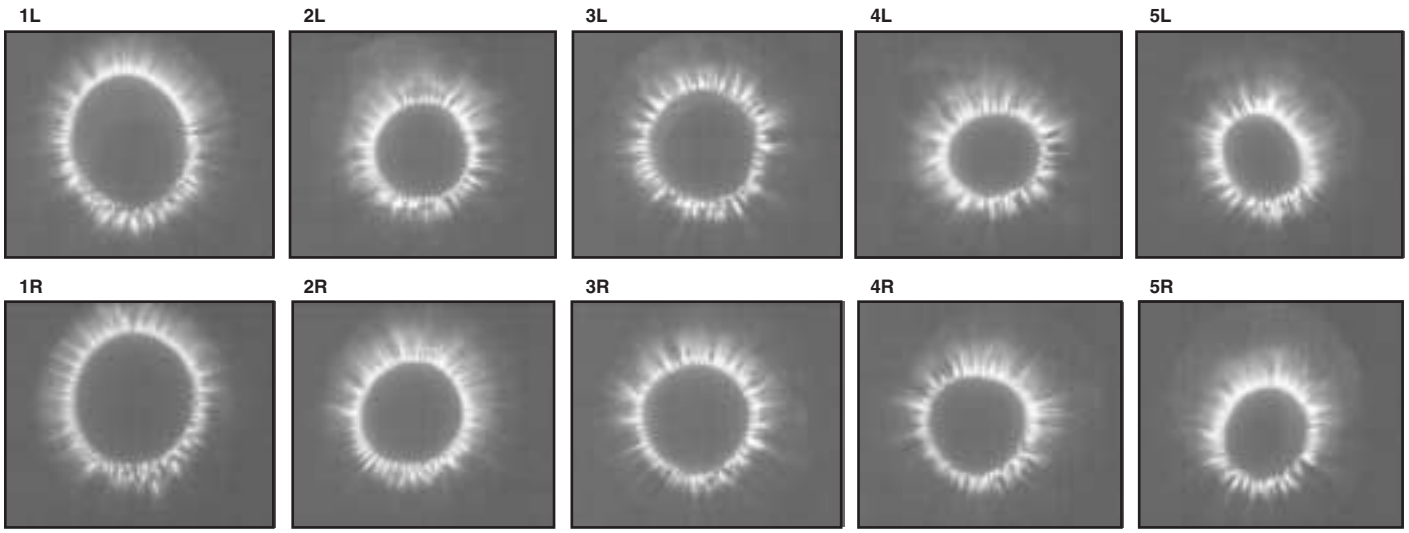

Fig. 2. Gas Discharge Visualization (GDV)-grams of all ten fingers of the same subject shown in figure 1, post-qigong. Fingers are labelled L (left) or R (right), and numbered sequentially from 1 to 5, with 1 indicating the thumb, and 5 indicating the little finger.

or minimal experience (<5 months) and those with experience (1.5–8 years). The presence of a chronic health problem was coded as a yes-no variable. Repeated measures General Linear Models were conducted to determine whether the pattern of change between pre- and post-qigong varied based on group membership (experienced vs inexperienced; healthy vs chronic health problem).

In the paired t-test analyses examining changes before and after the qigong session for the group of subjects as a whole, only one GDV parameter, density, showed a statistically significant change [$t(15) = -2.94$, $p < 0.01$]. Density increased at the post-qigong test (see table I). The means of all parameters for the whole sample are presented in table I. For the standard deviations of the finger means, a trend was found for fractality form coefficient [$t(15) = 1.87$, $p < 0.08$], the variation of which decreased at the post-qigong test. There was no change in integral symmetry (see table II). The means of the standard deviations of all parameters for the whole sample are presented in table II.

Prior to examining any pre- to post-qigong differences due to group membership (i.e. the experienced vs the inexperienced group, and the healthy vs the chronic health problem group), differences between the two groups at pre-test were examined. There were no differences in any of the dependent variables based on experience level or the presence of a health problem. In the analyses examining the influence of a chronic health problem, a statistically significant difference was found for fractality dimension [Wilks' lambda, $F(1,14) = 6.21$, $p < 0.026$]. Persons with a health problem showed an increase in fractal dimension at post-qigong, while those without a health problem showed a decrease (see figure 3). There were no significant differences between the use of standard deviations or integral symmetry as the dependent variables.

Table I. Paired t-test results: mean and standard deviation (SD) of finger means of Gas Discharge Visualization (GDV) parameters for the whole sample population, pre- and post-qigong session

GDV parameter	Pre-test [mean (SD)]	Post-test [mean (SD)]
Area	4.23 (0.99)	4.40 (0.97)
Brightness	105.87 (6.52)	105.16 (7.31)
Density	0.40 (0.04)	0.43 (0.04)*
Form coefficient	4.52 (1.36)	4.21 (1.00)
Fractality dimension	1.89 (0.10)	1.89 (0.15)
Left integral	0.48 (0.29)	0.56 (0.32)
Right integral	0.52 (0.30)	0.54 (0.27)

* $p < 0.01$.

Table II. Paired t-test results: mean and standard deviation (SD) [or variability of the SD] of finger means of Gas Discharge Visualization (GDV) parameters for the whole sample population, pre- and post-qigong session

GDV parameter	Pre-test [mean (SD)]	Post-test [mean (SD)]
Area	0.95 (0.35)	0.89 (0.35)
Brightness	3.97 (0.90)	3.94 (1.22)
Density	0.27 (0.01)	0.28 (0.01)
Form coefficient	1.25 (1.23)	0.77 (0.35)*
Fractality dimension	0.18 (0.07)	0.18 (0.06)
Left integral	0.27 (0.07)	0.34 (0.23)
Right integral	0.34 (0.19)	0.30 (0.17)

* $p < 0.08$.

In the analyses for duration of qigong practice, a trend was found for brightness [Wilks' lambda $F(1,14) = 3.42$, $p < 0.093$]. Experienced individuals showed a decrease in brightness pre- to post-qigong, while the reverse pattern occurred in inexperienced individuals (see figure 4). A trend for integral symmetry was also found [$F(1,14) = 3.92$, $p < 0.068$]. Both groups were comparable in symmetry at pre-test, with means close to zero indicating symmetry in the relative left-right energy field distribution. However, at post-qigong, the left integral increased in the inexperienced subjects, while the right integral increased in the experienced subjects (see figure 5). There were no significant differences with the standard deviations as the dependent variable.

Discussion

Partial support for our hypothesised changes in GDV parameters was obtained. We hypothesised that post-qigong emissions for all subjects would be larger because of enhanced energy flow. Only one parameter, total density, was found to increase post-qigong. Rather than size, a more subtle aspect of the GDV-grams changed. Increased total density was observed as the GDV-grams became more uniformly dense circles of light around the fingers. This may indicate improved energy regulation or, more specifically, improved energy flow and distribution in the acupuncture meridians, six of which end in the fingertips. The hypothesised increased symmetry between the right and left hands post-qigong was not confirmed.

Variability in the fractional form coefficient, as measured by its standard deviation, decreased post-qigong. This decrease in variability might indicate improved energy regulation. That is, the deviation from finger to finger of the external contour of each GDV-gram was reduced, and the GDV-gram rendered more uniform. This might indicate improved energy regulation, with energy more evenly flowing through the fingers, and more evenly

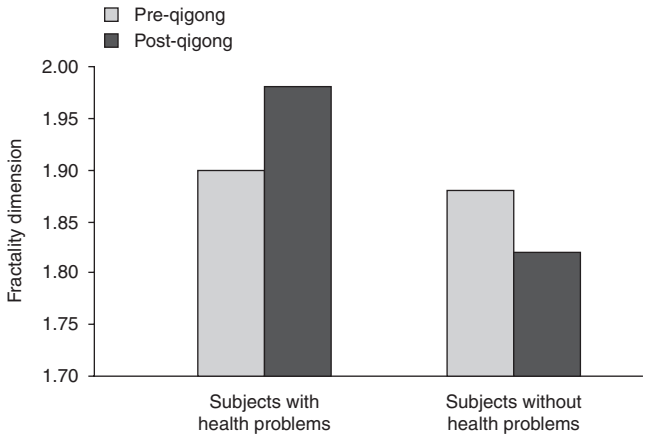

Fig. 3. Changes in fractality dimension as predicted by health problem. Differences between the subgroup with health problems and the subgroup without health problems, for the fractality dimension parameter, post-qigong session ($p < 0.026$).

distributed among the acupuncture meridians that end in the fingertips, and throughout the body, following the qigong session. In a related study conducted in a similar qigong workshop setting, electrodermal measurements were made using the *Ryodoraku* instrument, which assesses the electrical conductivity at the acupuncture points.[11] Similar reductions in standard deviations were obtained in post-qigong measurements, which were interpreted to mean an improvement in the energy balance between the acupuncture meridians.[11]

Duration of qigong experience was hypothesised to be associated with larger emission patterns. In fact, the opposite pattern was observed for only one parameter, brightness, with experienced individuals decreasing and inexperienced increasing brightness. This means that more photons of wavelengths detectable by the CCD were registered in the GDV-grams of inexperienced subjects post-qigong. We speculate that other energy frequencies instead of those that are visible, such as far-UV, may be emitted by the experienced subjects post-qigong. The CCD detector may be less sensitive to those energy frequencies or, in the case of UV, they are absorbed by the glass camera lens, thus reducing the brightness parameter for these subjects. It was previously demonstrated that the fingers may emit other frequencies in the GDV method besides those registered by the CCD.[20] Moreover, shifts in emission spectra have been noted in GDV-grams for subjects in altered states of consciousness.[27]

A difference in integral symmetry was also related to duration of qigong experience. Contrary to our hypothesis, symmetry decreased post-qigong. The direction of this pattern was reversed between experienced and inexperienced subjects: experienced subjects showed an increase in the right integral, while inexperienced subjects showed an increase in the left integral. One possible explanation for this finding may relate to hypothetical functions of the right and left sides of the body according to various principles of energy medicine and indigenous medicine. The left side of the body is thought to be the yin, receptive side, while the right side is considered the yang, actively giving side. Perhaps the inexperienced subjects are 'receiving' energy through the left during qigong, while the more experienced subjects engage in a 'giving' energy mode.

The presence of a chronic health problem was related to increased fractal dimension, as hypothesised. This means that the GDV-grams show more irregularity in their external contour for subjects with chronic health problems. This is considered to be a sign of poor energy regulation, when qi is not flowing smoothly in the body, yielding GDV-grams with ragged edges or gaps in the emission pattern, as would be expected from persons with a serious health problem. Such finger emission patterns showing gaps or jagged contours at specific sites have been documented for a wide range of illnesses by Mandel.[19]

According to TCM and Oriental philosophy, qi is thought to be imbued with energy, information and consciousness. As such, when performing qigong, qi may move in the body precisely where it needs to go, in order to facilitate well-being. Therefore, the result of performing qigong may be highly specific to a subject's health needs, and may not be generalisable for a diverse population of subjects performing qigong. Thus, our original hypotheses may not be entirely applicable herein, especially since we have such a diverse population including seven chronically ill subjects, each with a different disorder, among a total of 16 subjects.

In addition to our parametric analysis, there are other software analyses of the GDV-grams that have not been included here.

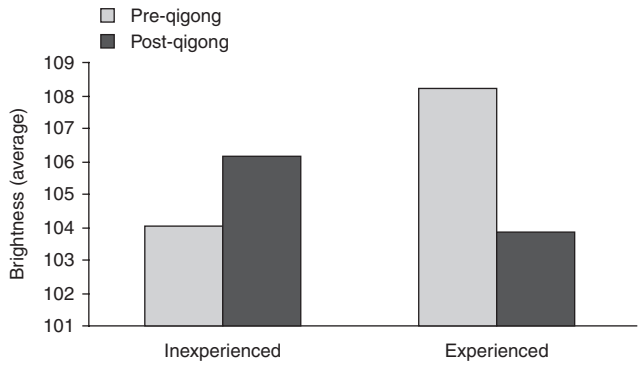

Fig. 4. Changes in brightness pre- to post-qigong by duration of qigong practice. Differences between the inexperienced subgroup and the experienced subgroup, for pre- to post-qigong changes in the brightness parameter ($p < 0.093$).

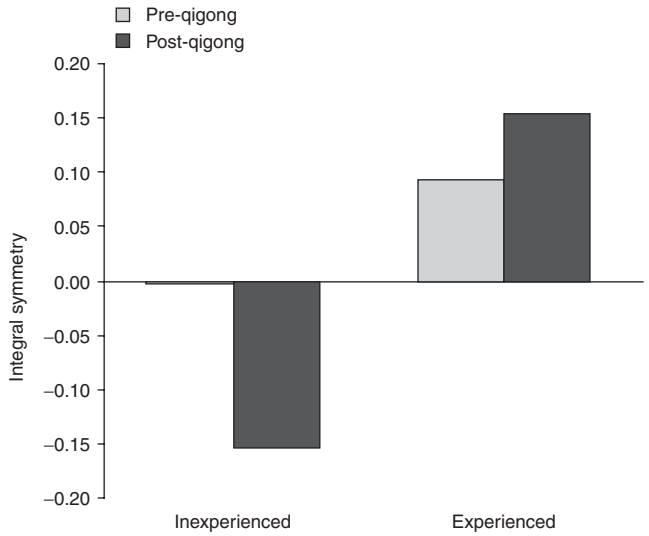

Fig. 5. Differences between integral symmetry for the inexperienced and the experienced subgroup post-qigong ($p < 0.068$). Integral symmetry is defined as JS (R) – JS (L) for each subject in a particular pre- to post-qigong condition, where JS (R) is the integral parameter for the right (R) hand measurements and JS (L) is for the left hand.

These involved sector analyses for specific organ functions according to Mandel[19] and chakra analyses.[28] These do not lend themselves to statistical analyses with small populations. Preliminary results involving several subjects (data not shown here) indicate pre- to post-qigong results that are meaningful on an individual basis with respect to their specific health problems, but not generalisable to the sample population as a whole.

Results from other laboratories show that the GDV-grams of elderly persons are very stable and subject to less influence than younger persons.[29] Despite the fact that our sample population was elderly, our study showed some significant differences as well as trends in the changes of GDV parameters post-qigong. This may indicate the power of qigong to shift the energy dynamics even in an aging population.

Conclusion

Qigong was shown to influence some of the calculated GDV parameters of the finger emission patterns significantly; however, our results only partially support our original hypotheses. As an initial study with a small group of subjects ($n = 16$) of varied ages and health conditions, for which we observed mostly trends but not highly significant ($p < 0.05$) results, no strong conclusions can be made. The small sample group and the lack of a control group may have hindered our ability to detect other significant changes. In addition, our sample was fairly restrictive, being primarily elderly, with almost half having a chronic health problem. Future studies would need to be conducted with broader samples to confirm our findings and ascertain the full range of applicability of GDV technology for qigong.

The GDV technique may be a valuable tool in the clinic to assess rapid responses in patients to examine the effectiveness of energy medicine modalities and practices such as qigong. Such changes in the biofield parameters are expected to take place before measurable changes in the patient's physiology or biochemistry, since, according to TCM, 'blood follows qi'. For researchers, the GDV technique may be useful in assessing changes in parameters of the human biofield in response to an intervention in order to delineate the initial steps in the mechanism of action of complementary and alternative medicine interventions.

Acknowledgements

This study was supported in part by NIH grant P20 AT00774 from the National Center for Complementary and Alternative Medicine (NCCAM) and a grant from the Lifebridge Foundation. The contents of this paper are solely the responsibility of the authors. The authors have no conflicts of interest that are directly relevant to the contents of this study.

The authors thank Bett Lujan Martinez for her helpful input; Bett Lujan Martinez and Effie Chow, PhD for the opportunity to conduct the study; and Brian R. Faust for his assistance with the manuscript.

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Correspondence and offprints: Dr *Beverly Rubik*, Institute for Frontier Science, 6114 LaSalle Avenue, PMB 605, Oakland, CA 94611-2802, USA.
E-mail: brubik@earthlink.net