Research Leading to a Systems/Cellular/Molecular Model for the Benefits of Qigong and Tai Chi on Health and Healing

Shin LIN

Laboratory for Mind-Body Signaling & Energy Research and Susan Samueli Center for Integrative Medicine, University of California (Irvine, USA)

Abstract: The goal of our research is to apply modern biomedical technologies to develop experimental approaches, protocols, and instrumentation, and use them to quantify physiological and bioenergetic changes associated with the practice of Qigong and Tai Chi. In our studies on dozens of high level practitioners and many control subjects over the last few years, we have shown that Qigong and Tai Chi (a) increase blood flow measured by laser Doppler flowmetry, (b) induce a state of relaxation as indicated by heart rate variability analysis of electroencephalography and brain wave analysis of electroencephalography, and (c) elevate bioenergy emission in the form of heat (infrared thermography), light (single photon counting), electrical charge (gas discharge visualization), and conductance at acupuncture points (pre-polarization measurement with single square voltage). Based these results and previous studies by other investigators, we propose a working model for explaining the many effects of Qigong and Tai Chi on health and healing at the systems, cellular, and molecular levels. We hope that our on-going experiments and this model will stimulate future research that leads to a better understanding of the scientific basis of the these practices and thus accelerate their integration into the global healthcare community.

Keywords: Qigong, Tai Chi, Physiology, Bioenergy, Health and Healing, Systems-Cellular-Molecular Model

1. Introduction

The many different styles and schools of Chinese mind/body practices involving regulation of mind, body, and respiration (i.e., Qigong and Tai Chi), are traditionally thought to enhance health and healing by improving the level and circulation of “Qi”, the Chinese term for vital energy (1-3). Because Qi is an ancient concept that does not have a precise scientific definition (2), the goal of research in our laboratory is to apply modern biomedical technologies to develop experimental approaches, protocols, and instrumentation, and use them to quantify physiological and bioenergetic changes associated with the practice of Qigong and Tai Chi. This paper summarizes our progress and presents a model based on our studies and those of others to explain the major benefits of Qigong and Tai Chi at the systems, cellular, and molecular levels. We hope that our work and this model will stimulate future research that leads to a better understanding of the scientific basis of the these practices and thus accelerate their integration into the global healthcare community.

2. Physiological Changes Associated with Qigong and Tai Chi Practices

There is a considerable volume of literature documenting how Tai Chi as a physical exercise can improve musculoskeletal parameters such as body flexibility and balance (4-6). Other studies have shown that Tai Chi and Qigong practices can improve indicators of health such as blood pressure, lipid profile, self-report of stress reduction, and immune markers (5-9). In this part of our studies, we focused on the effects of Qigong and Tai Chi on the nervous system and the cardiovascular system. The following is a summary of results obtained from on-going studies involving several dozen high-level practitioners as well as many control subjects.
a. Effects on the Autonomic Nervous System.

Heart rate variability (HRV) analysis of data from electrocardiography (EKG) is becoming an increasingly common method to non-invasively evaluate autonomic nervous function. In many studies, low frequency variability (LF, < 0.15 Hz as shown in the power spectrum produced by fast Fourier transformation of time series data) is taken as an indicator of sympathetic tone, and high frequency variability (HF, ≥ 0.15 Hz) as an indicator of parasympathetic tone (10). To examine how HRV can be applied to the study of physiological changes associated with mind/body practices, we used a portable Holter system designed by our collaborator Dr. Zhong-Yuan Shen of the Qigong Research Institute at the Shanghai University of Traditional Chinese Medicine. The system has the capability of simultaneous recording of EKG and respiratory pattern measured with chest and abdominal straps containing stretch transducers.

Based on studies on over a dozen Qigong and Tai Chi practitioners and 20+ control subjects, we determined that a number of factors can significantly influence HRV (11). First, the frequency of the breathing cycle influences the frequency of the HRV peak produced by a mechanism referred to as respiratory sinus arrhythmia (RSA). Thus, a practitioner with a heart rate of 60 beats per minute will produce a HF peak at 0.2 Hz by regulating breathing at the rate of 12 cycles per minute, and a LF peak at 0.1 Hz when the breathing rate is slowed down to 6 cycles per minute. This shift from HF to LF is not necessarily a reflection of a change from a state of relaxation to a state of stress (i.e. higher parasympathetic to higher sympathetic function) as previously stated (10). Furthermore, multiple HF peaks may be produced by breathing at different rates during the measurement period (e.g., 3 different peaks produced by breathing at 8, 12, and 16 cycles per minute at different time intervals), thereby complicating the analysis of the power spectrum. On the other hand, we have also found in some cases involving younger subjects what appeared to be harmonics at higher frequencies even though they were strictly controlling their breathing at a single rate throughout the measurement period. For example, a subject in his early twenties breathing at a steady rate of 6 cycles per minutes (0.1 Hz) could still produce peaks at 0.2, 0.3, 0.4 Hz, etc., with diminishing amplitude in both the power spectra of the HRV and of the breathing pattern.

Second, the size of the HRV peak produced by RSA is dependent not just on the tidal volume of each breath, but also on the posture of the subject. For instance, a subject breathing at a controlled rate and volume will show a larger peak in the sitting position compared to the standing position, and an even larger peak in the supine position. Therefore, it is difficult to directly compare the HRV of a given subject practicing meditation in the sitting position and in the standing position. On the other hand, it is important that for those subjects who were in the sitting position throughout the experiment, their HF peak tended to increase in size during meditation compared to the periods before and after the practice (12,13). Because a high HF peak was also seen during a period of deep sleep in control subjects, this result supports the notion that meditation is a very effective way to reach a state of rest and relaxation.

Third, under the same conditions, younger subjects (20-25 year olds in this study) generally show a larger peak produced by RSA compared to older subjects (50-70 year old). This effect sometimes overshadows differences based on other considerations, such as years of training in mind-body practices.

In conclusion, this part of our study shows that HRV analysis can be a useful tool for assessing autonomic nervous function in mind/body practices (13), but great care must be taken to control all of the factors indicated above.

b. Effects on Brain Function.

Pilot experiments involving electroencephalography (EEG) were conducted in collaboration with Dr. Ramesh Srinivasan at the Cognitive Science Department of University of California, Irvine, and with Dr. Tzyy-Ping Jung at the Swartz Center for Computational Neuroscience of the University of California, San Diego (12). A number of experienced Qigong and Tai Chi practitioners were recorded with a 128-channel EEG system (Geodesic Sensor Net System from Electrical Geodesic, Inc.) before, during, and after meditation in the sitting position. With highly experienced subjects, there was an increase in alpha and...
theta waves recorded at the frontal mid-line area of the head within minutes into the meditative period compared to the baseline level recorded before and after this period. When the EEG data were further examined by the method of Independent Component Analysis (14), we found that the increase in alpha and theta waves was also accompanied by an increase in beta waves (12,13). Since alpha and theta waves signify a state of relaxation and rest while beta waves reflect a state of alert consciousness, this analysis indicates that meditation is a dual state of “relaxed concentration”. This conclusion is consistent with the commonly held notion that meditation is not only an excellent means to achieve deep rest, but also an effective way to train the mind to be sharply focused during mental activities in every day life.

c. Effects on the Circulatory System.

In Traditional Chinese Medicine, the close relationship between blood flow and Qi is illustrated by the common sayings “blood is the mother of Qi” and “when intention comes, so comes the Qi, and so comes the blood”. In this part of our studies, peripheral blood flow was measured by laser Doppler flowmetry (15) at the skin level (i.e., cutaneous blood flow) by placing a probe of the instrument (Model DRT4 from Moor Instruments, Ltd.) on the Lao Gong (PC8) acupuncture point (acupoint) on the palm.

A dozen subjects were instructed to perform the single-handed silk-reeling exercise of Chen Style Tai Chi, which consists of a slow, repetitive, elongated circular movement of the right arm and an up-and-down movement of the legs, all coordinated with deep breathing cycles at the rate of about 4 times per minute. This type of exercise, as well as some other Tai Chi and Qigong movements, were found to increase the “flux” of blood flow (i.e., speed multiply by the number of red cells within the volume of tissue measured) measured at the moving hand by ~50-300%. In general, this increase in blood flow was primarily due to the arm movement. The coordinated leg movement and deep breathing cycles were also contributors to this effect, but the degree of their effects varied from subject to subject. In general, the overall effect of Qigong and Tai Chi practice on blood flow tends to be greater when the subject is more experienced and more mentally and physically relaxed.

To have a better understanding of the effect of breathing regulation on blood flow, we made simultaneous recordings of EKG, breathing pattern, and blood flow on subjects during deep breathing cycles. It was apparent from the analysis of the combined data that the increase in instantaneous heart rate (measured as time interval between two beats) caused by the slow, deep inhalation phase (i.e., RSA as described in Section IIA) led to increased blood flow (16). Thus, proper coupling of deep breathing cycles with certain Qigong and Tai Chi movements can further increase blood flow as described above. In general, the combined effect tends to be greater for more experienced subjects.

3. Bioenergetic Changes Associated with Qigong and Tai Chi Practices

In Traditional Chinese Medicine, the healing effects of Qigong are often explained as enhancement of the level and flow of Qi. Western biomedical research on these two types of interventions has been hampered by the lack of a strict scientific definition of Qi, which is based more on human feelings and experiences rather than the physicist’s definitions of energy, force, fields, etc. (2). One approach around this dilemma is to study those changes in energy that are measurable with modern instrumentation. Our studies to date have indicated that Qigong and Tai Chi practices do produce a number of measurable energy-related changes.

a. Effects on Electrical Conductance at Acupoints.

The “Single Square Voltage Pulse” (SSVP) method was developed by Motoyama to measure conductance before polarization (BP) and after polarization (AP) at jing-well acupoints (17). He proposed that BP is an indication of the bioenergy of the corresponding meridians while AP is related to stress commonly measured as galvanic skin response (17,18). Besides measuring the conductance values with a 1 millisecond pulse of 3 volts rather than with a constant current, the method also incorporates the use of a hand-held electrode probe with a flexible shank to make electrical contact with an adhesive sponge.
electrode pad pre-placed on the acupoint, a method designed to minimize physical stimulation of the acupoint by the probe during the measurement.

We conducted a detailed examination of the variability of the SSVP instrumentation (AMI Care System from AMICA Co., Japan) and methodology under different conditions (19). First, by using a micromanipulator (Model M from Leitz Corp., Germany) to place the electrode probe onto an electrode pad adhered to the jing-well acupoint of the Pericardium Meridian on the hand, we showed that the average variability values of the BP and AP measurements were 0.6% and 2.0%, respectively, based on 165 sets of 27 continuous measurements on 6 subjects made without lifting the probe off the electrode pad. These values represent the minimum achievable reproducibility of the SSVP method under idealized conditions. Furthermore, we found that increasing the pressure of the probe on the electrode pad by adjusting the setting on the micromanipulator resulted in an increase of the BP value by 3-5%, with occasionally a slight increase in variability. Under normal experimental conditions when the probe was placed by hand on electrode pads on all 28 jing-well acupoints on the hands and feet of 5 subjects, the variability was 8% for BP and 15% for AP, based on 10 rounds of measurements with the same set of pads.

How mind-body exercises might affect BP and AP values was investigated in our study involving measurement of 9 advanced subjects (3 of them measured twice) with an average of 23 years of experience before and after 15-20 minutes of Tai Chi practice (13,16). We found that in all cases, there was an increase of overall BP (average of BP measured at the 28 jing-well acupoints) ranging from 8-26% (average of 17%). In related experiments involving some of these subjects as well as other control subjects, riding a stationary bicycle and lifting weights produce little or no effect on BP values. Compared to BP, we did not find a definitive pattern of change with respect to overall AP values in subjects practicing Tai Chi in this study (6 cases increased, 4 cases decreased, and 2 cases showed no change).

In conclusion, this part of our studies shows that the SSVP method has a low level of variability particularly when the difference in pressure exerted by the electrode probe on the conducting electrode pad is minimized. The study on Tai Chi practitioners indicates that BP values can be a useful marker for studying the bioenergetic effects of mind-body practices.

b. Effects on Biophoton Emission.

The human body is known to emit a low level of energy in the form of light in the visible range of the spectrum. This form of energy is referred to as biophotons (20). In this part of our studies, we assembled a system that can quantify biophoton emission from the palm of the hand with sensitivity at the level of a single photon (21). The instrumentation consists of a photomultiplier tube sensitive to light of ~300-600 nm (Integrated Counting Head, Model H59020-01 from Hamamatsu Corp., powered by Linear Power Supply, Model LPS-304/CE, from AMREL), connected to a timer/counter/analyzer (Model PM6680B/016, from Fluke), which sends the information to a standard desktop computer for analysis with the TimeView software. The photomultiplier tube, mounted on a stable frame to guide the placement of the hand, is housed inside a lightproof chamber with a sleeve for insertion of the hand.

We determined that a number of parameters must be precisely controlled in order to produce reliable data with our single photon counting system (21). First, while the background noise of the photomultiplier tube is sufficiently low and constant for this type of application (“dark counts” obtained in the absence of the hand are about 10 counts per second), it goes up rapidly when the temperature of the tube rises above 25°C. Thus cooling of the tube with a coil containing circulating water of a set temperature is essential to its proper operation. Second, the photon count decreases steadily with distance of the hand from the photomultiplier tube. Third, biophoton emission is highest at the center of the palm (i.e., around the Lao Gong, PC8, acupoint), and decreases towards the fingertips. Fourth, exposure of the hand to direct sunlight for even a few minutes can increase biophoton emission by 100 times or more for a couple of hours. Normal indoor lighting has relatively small effect on biophoton emission unless a subject’s hand is within a few feet from a light bulb. Fifth, body temperature is another important factor affecting biophoton emission. In a study involving 10 control subjects, warming the hand to increase its temperature by 3°C increased biophoton emission by about 15% while cooling the hand by 14°C resulted in a similar level of
change in the opposite direction. By carefully controlling all of the factors described above, we can achieve a low variability of around 2-5% in our biophoton measurements.

Our single photon counting system was used to investigate the effect of different types of exercises on biophoton emission (21). First, 7 subjects were instructed to ride a stationary bicycle with hand and foot pedals (Airdyne from Schwinn) at a comfortable speed of around 60 cycles/minute for 15 minutes. Afterwards, 6 of the subjects showed an average increase in biophoton emission of 45% while one showed no change. Second, 12 subjects with no previous Tai Chi experience were instructed to perform the “silk reeling” movement of Chen style Tai Chi for 15 minutes. Afterwards, 11 of the subjects showed an average increase in biophoton emission of about 15% while one subject showed no significant change. As indicated below, a highly trained Tai Chi practitioner produced a higher level of change, but more experiments must be done to see whether this difference is statistically significant. In any case, this preliminary study shows that with careful control of the factors described above, the single photon counting system can produce useful data on the effect of exercises on bioenergy emission in the form of visible light.


Our ongoing studies have indicated that Tai Chi and Qigong can increase bioenergy measured as electrical conductance and biophoton emission (13,16,19, 21). To distinguish the effects of mind-body exercises from physical exercises, we directly compared 20 minutes of practice of the slow-soft movements from Old Frame Routine 1 of Chen Style Tai Chi (from which Yang Style Tai Chi was derived) with the relatively fast-hard movements from Routine 2 (similar to those of many ‘hard” Kung Fu styles) (22). The subject in this pilot experiment was one of the top leaders of Chen Style Tai Chi from the Chen Family Village in China (birthplace of Tai Chi), who has more than 40 years of training in this type of practice. The effects of Routine 1 and Routine 2 were measured separately on two consecutive days. At least three sets of measurements were made with each instrument for each condition and the results were presented as averages.

First, the fast and hard movements of Routine 2 increased heart rate about twice as much as Routine 1 movements, reflecting the fact that it is a more vigorous physical activity. Second, the slow and soft movements of Routine 1 compared to Routine 2 movements produced a greater increase in pre-polarization electrical conductance at 28 jing-well acupoints measured with the Motoyama’s single square voltage pulse method (18% vs 8% for hand acupoints and 42% vs 31% for foot acupoints), consistent with our previous observation that Tai Chi and Qigong can produce a bigger increase in this type of measurements compared with physical exercises such as riding a stationary bicycle and lifting weights (16). Third, the Routine 1 movements produced a greater increase in biophoton emission measured with the single photon counting system (55% vs 15%). Finally, the Routine 1 movements also produced a higher level of heat emission measured at the palm with infrared thermography (increase of 1.0 °C vs 0.6 °C), as well as a greater change in bioelectrical charge measured at the 10 finger tips with the method of gas discharge visualization (23) (+7% vs –4 % in average area of discharge pattern of all finger tips). The results of this case study indicate that for a top level Tai Chi practitioner, the slow and soft mind-body type of movements produced a greater change in all of the bioenergy markers measured compared to the more physical type of movements.

d. Effect on Physical Strength.

We wanted to see if the increase in bioenergy measured as heat, light, and electrical parameters produced by Tai Chi practice could also be measured in terms of physical strength. In a pilot study involving 5 subjects, the maximum weight they could lift a single time (referred to in weight training as 1-Rep Max) in a standardized test with a Bowflex machine was calculated as previously described (24). For each subject, the measurement was made on one day and repeated on a different day after practicing 15 minutes of Tai Chi silk reeling movements. We found that all 5 subjects were able to lift an average of 10% more weight when the measurements were made following the Tai Chi practice. This level of increased strength is roughly equivalent to the gain from a few weeks of weight training in the absence of any Tai Chi practice. Thus, it appears that the bioenergy increase produce by Tai Chi practice can also be measured as an increase in physical strength.
The studies described above indicate that Tai Chi and Qigong practices can increase both blood flow and bioenergy markers, consistent with the Chinese concept of “blood is the mother of Qi”. This relationship was further investigated in experiments in which blood flow was artificially increased by elevating the temperature of the hand by immersion in ~40°C water for 1-3 minutes (25). This treatment, which increased the temperature of the hand measured by infrared thermography by 3°, produced similar increases in biophoton emission and pre-polarization conductance at acupoints at the hand as practicing Qigong and Tai Chi. Reducing the temperature of the hand by 14°C by immersion in iced water for about a minute produced opposite effects.

In a related experiment, blood flow was artificially increased by pushing the head of an electrical percussion massage instrument (Thumper Mini Pro, from Sharper Image) against the palm of the hand for 1-5 minutes to simulate the self-massage movements of some types of Qigong practice (25). This treatment also increased the bioenergy markers in a manner similar to warming up the hand.

In conclusion, these two experiments indicate that increased blood flow correlates with elevation of bioenergy markers, consistent with the traditional concept of a close relationship between blood and Qi. The biological mechanisms by which these parameters are related remain to be determined.

4. A Model for Explaining the Benefits of Qigong and Tai Chi

Based on our studies and on previous work by other investigators, a model for the myriad of healthful benefits of Qigong and Tai Chi practices on mind-body functions can be presented at the systems, cellular, and molecular levels.

a. Improvement of Physical and Metabolic Markers.

There is abundant evidence that Tai Chi can improve musculoskeletal parameters such as body flexibility, muscle strength, and balance (4-6). The latter effect is a result of Tai Chi’s emphasis on moving the entire body as a single unit and the deliberate placement and shifting of body weight for maximum stability. The increase in body balance with this type of training translates into a reduction of falls (26), an important outcome particularly for the health and well-being of the elderly.

There are other studies showing that Tai Chi and Qigong practices improve health indicators such as blood pressure and lipid profile (7,8), benefits that can also be derived from various forms of physical exercises. A recent study found that Tai Chi also lowers the diabetic indicator hemoglobin A1c (27), supporting the common belief that it is an excellent activity for diabetic patients. This effect can be explained by previous research showing that contraction of muscles can stimulate secretion of interleukin-6 from this tissue (28). This type of cytokine accelerates breakdown of stored fat (lipolysis) and increases insulin sensitivity in the body, but at higher levels also enhances the inhibitory action of cortisol on the immune system (29). As a mild form of physical exercise, Tai Chi can stimulate secretion of interleukin-6 from muscle tissues to produce beneficial effects on lipid and sugar metabolism, but not reaching a high enough level to inhibit the immune system compared to more vigorous physical activities such as riding a bicycle at full speed for an extended period of time (28).

The practice of repetitive movements of Qigong and Tai Chi (e.g., silk reeling exercises in Chen style Tai Chi and hand-guided deep breathing exercises referred to as “pulling air” in Wu Dang Qigong) can have additional benefits on many other physiological functions. Studies on cats have demonstrated that repetitive movements (i.e., grooming) can lead to a several fold increase in the activity of serotonin neurons in the brain (30). These neurons connect widely with many parts of the brain and regulate directly or indirectly diverse physiological functions, including control of mood and emotion, sleep, digestion, cardiovascular and mental activities. Thus one could extrapolate from the animal studies that many of the beneficial effects of Qigong and Tai Chi could conceivably stem from the repetitive movements in these exercises.

It is common knowledge that physical exercises increase blood flow, particularly in the body directly involved in the activity. If the exercise is strenuous (lifting heavy weights), it becomes a stress to the body, inducing an increase in the tone of the sympathetic branch and a decrease of tone of the parasympathetic branch of the autonomic nervous system (31). This shift in autonomic balance leads to vasoconstriction all over the body except at the muscles directly involved (e.g., the biceps brachii in "biceps curl"). Qigong and Tai Chi movements, on the other hand, tend to be soft and slow and involve all parts of the body. Therefore, the effect is an increase in blood flow all over the body, particularly when the practitioner is in a relaxed mental and physical state and therefore high in parasympathetic tone. While this has not yet been a focus of our studies to date, results from pilot experiments with laser Doppler flowmetry are consistent with this notion.

The multi-functional Holter monitor system for simultaneous recording of EKG and breathing pattern allowed us to gain a better understanding of how the slow and deep breathing cycles in Qigong and Tai Chi can lead to an increase in heart rate and cardiac output. This phenomenon is mediated by the physiological mechanism referred to as respiratory sinus arrhythmia, which has previously been shown to be mediated mainly by the autonomic nervous system (32). Furthermore, by coupling the use of the Holter system with laser Doppler flowmetry, we can see how the effect of deep breathing cycles can add to the increase in blood flow due to Qigong and Tai Chi movements.

In conclusion, we can see how the essential elements of regulation of body, breath, and mind in Qigong and Tai Chi practices can contribute to enhancement of health and healing by increasing the transport of oxygen, nutrients, signaling factors, and waste materials by elevating blood flow all over the body.

c. Inducement of Relaxation

It is well recognized that a major reason mental stress is a serious detriment to good health is because of its inhibitory effect on the immune system, an action mediated by the stress hormone cortisol (33). In contrast, relaxation leads to a lowered sympathetic tone and subsequent decrease in cortisol secretion by the adrenal glands. In a pilot study, subjects who practiced Guolin Qigong (designed for cancer patients with emphasis on regulated breathing coordinated with a special style of walking) for 14 weeks had 20% lower cortisol and higher number of white blood cells secreting certain cytokines compared to the time when they started their training (9). Another study showed that practicing an exercise derived from Tai Chi measurably increased cell mediated immunity (34). Consistent with that study, our analysis of heart rate variability and brain wave patterns in preliminary experiments indicated that Qigong meditation in the classical sitting position induced a state of relaxation. These findings are consistent with previous studies on other types of meditation (35,36). In collaboration with Dr. Zhong Yuan Shen of the Qigong Research Institute of the Shanghai University of Traditional Chinese Medicine, we are in the process of testing more advanced Holter monitors that are capable of simultaneous recordings of not just EKG and respiratory function, but also EEG and electromyography (EMG). This system should be valuable for more in depth studies on the “moving meditation” aspects of Tai Chi and Qigong practices in the future.

In conclusion, Qigong and Tai Chi are similar to many other types of mind-body practices in terms of inducing relaxation and relieving stress. By decreasing sympathetic function and increasing parasympathetic function of the autonomic nervous system, Qigong and Tai Chi can reverse stress-related effects such as inhibition of the immune system and poor blood circulation due to vasoconstriction.

d. Elevation of Bioenergy

Our single photon counting system for measuring light emission from the body proved to be a useful method for evaluating bioenergy changes associated with mind-body exercises. We used this instrument in combination with the more established technologies of laser Doppler flowmetry, gas discharged visualization, infrared thermography, and the single square voltage pulse method to demonstrate a close
relationship between the increase in different forms of bioenergy and the increase in blood flow, two types of effects produced by Qigong and Tai Chi practice and also by heat and massage treatments.

What is the physiological significance of increased bioenergy resulting from Qigong Tai Chi practice? Recent research on the relationship of electrical field and wound healing has provided information that might be relevant to this important question. The skin of humans and animals is known to emit an electrical field of ~10 V/m under normal conditions, and the field goes up to ~100 V/m during wound healing (37-39). In a recent study, an externally applied D.C. electrical field of ~10-100 V/m was shown to enhance cell migration in the closing up of artificially created wounds in cell cultures (37). To investigate the molecular basis of this phenomenon, gene knockout experiments were conducted and it was found that the electrical effect on cell migration during wound healing involves the phosphorylation enzyme phosphatidylinositol-3-OH kinase, and the dephorylation enzyme PTEN (abbreviation for Phosphatase Tensin Homology protein) (37). These two enzymes are known to be involved in many other cellular signaling pathways, including the ones that regulate the movement of cells towards chemical attractants (chemotaxis) (40, 41), and normal vascular development and tumor angiogenesis (42). Of particular interest to our research group is the fact that PTEN, first recognized as the product of a tumor suppressor (chemotaxis) (40, 41), and normal vascular development and tumor angiogenesis (42). Of particular interest to our research group is the fact that PTEN, first recognized as the product of a tumor suppressor gene (43), was named on the basis of its enzymatic activity and its structural homology with the gene for the cytoskeletal protein Tensin previously discovered in our laboratory (44). Thus, based on existing knowledge, we can propose a molecular and cellular model for how Tai Chi and Qigong practices can conceivably enhance healing in the body by stimulating cellular migration as a result of increased bioenergy especially in the form of electrical field. Clearly, the validity of this model needs to be tested in further experiments the future.

References


http://www.ifpa-fitness.com/Fitness-Resources/Charts/Estimating_1rm_and_training_loads.htm


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Name: Shin Lin, Ph.D.

Address: 4230 McGaugh Hall, University of California, Irvine, CA 92697-2300, U.S.A.

Contact: e-mail: shinlin@uci.edu
Tel.: 949-824-4696
Fax: 949-824-4709


Area of Research: Physiological and bioenergetic changes associated with Qigong and Tai Chi practices.