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THE MECHANISM OF AURICULOTHERAPY: A CASE REPORT BASED ON THE FRACTAL STRUCTURE OF MERIDIAN SYSTEM

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Abstract

Background: Chinese meridian system of acupuncture has recently been deciphered as the fractal continuum of neurovascular bundles and its smaller branches. The corresponding acupuncture mechanism of therapeutics has been attributed to the magneto-electric inductive effects of the meridian system via chaotic wave of nerve innervations and blood flow. Hence, based on the proposed theory, the important sensory organ of the ears should be able to exert its influence on visceral organs and peripheral limbs. This investigation aims to verify if such a possible correlation exists between an external region of the ear and the muscle of *biceps brachii* in the French auriculotherapy.

Materials and Methods: A region between the points of elbow and shoulder in the scaphoid fossa (upper arm), was chosen. Before the recording of surface electromyograms (EMGs), of the muscle of *biceps brachii*, two subjects were asked to carry out maximum voluntary isometric contractions (MVICs), of the arm. In addition, the same volunteers would be served as control group. Consequently, each subject was required to perform the three treatments of control, sham, and acupressure in random order. EMG signals were recorded for later analysis.

Results: Results indicate that the acupressure with finger at a specific point which bears possibly with a somatopic relation to the *biceps brachii* muscle can, in a man, modify the response of the EMGs associated with the corresponding muscle while the response of the acupressure of a sham point has different responses. Moreover, the MVIC parameters were higher in acupressure treatment than those of control and sham treatments for both subjects.

Conclusion: In conclusion, the analysis of the findings permits us to speculate that the stimulation with the fingers in the scaphoid fossa of the ear presents electromyographic responses related to the *biceps brachii* muscle. Hence, the mechanism of French auriculotherapy could be derived from the same principle as that of the Chinese acupuncture.

Key Words: auriculotherapy, chaotic wave theory, fractal structure, meridian system, surface electromyography.

Introduction

Traditional Chinese medicine (TCM), has been a holistic form of medical treatment for about 5,000 years of history. TCM comprises various practices, such as traditional Chinese herbal medicine, acupuncture, acupressure, massage (tui na), qi gong, moxibustion and cupping (Teng et al, 2006, Lee et al, 2010, Lauche et al, 2012, Wang and Xion, 2013). The ancient theory of disease in TCM is based on the concept that the functional disorders of human beings are due to alterations and in consequence imbalances of the Qi and Xue. The special channels that carry and

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transport Qi and Xue are called “meridians”. Recently, an emerging theory suggests that the ancient “meridian system” is actually the complex network of neurovascular bundles and its smaller branches that connect internally with the viscera and externally with the peripheral limbs and sensory organs (Chang, 2012). This network is actually a fractal continuum with self-similar structure. In order to treat various physiological disorders due to the imbalance of Qi and Xue, the agents in acupuncture are usually needles, but other agents can also be used (Teng et al, 2006, Chang, 2010).

For several thousand years, the mechanism of acupuncture was not comprehended. It seems to be quite complicated, baffling, and not well-known. The clinical evaluations have indicated that Chinese acupuncture is effective in treating various diseases. It is actually a nonspecific therapy that can handle a broad spectrum of indications. Any proposed mechanism of acupuncture has to be able to explain how it works for all of the diseases and disorders. To date, most of the studies on acupuncture mechanism have been concentrated on explaining the actions of acupuncture concerning just one specific type of physiologic malfunction. This is not good enough. One plausible mechanism based on the chaotic wave theory of fractal continuum in terms of the neurovascular network has been proposed only recently (Chang, 2013a, Chang 2013b).

Similar points to the traditional acupoints of acupuncture that were found in the body, specific ones are also found around areas of the sensory organs, such as those on the ears of auriculotherapy. They can represent, in a typical anatomical map, organs and systems of different parts of the organism, and can be used to treat clinical disorders (Alimi et al, 2003, Asher et al, 2010). Auriculotherapy can be used alone or associated with a technique of the TCM (Asher et al, 2010). This technique was originally developed in France by the neurologist and acupuncturist Paul Nogier about 70 years ago. Recently, this French auriculotherapy has been identified as a possible body mapping on the ear with remarkable consistency with respect to anatomic and embryological considerations (Round et al, 2013). In this theory, the ‘‘inverted fetus’’ was represented by the musculoskeletal or mesodermal projections on the upper aspect of the ear, including the anti-helix, scaphoid fossa, and triangular fossa according to Nogier studies (Nogier, 2009, Round et al, 2013). It was considered, in general, that there was a possible somatotopic organization of the ear with direct relation to the human body and can be functioned through the branches of pairs of cranial nerves innervating the whole ear. In consequence, the stimulation of auricular points in the ear could generate effects in specific parts of the body (Round et al, 2013). This theory seems to be conformable to the aforementioned theory of Chang (Chang, 2012).

For the auricular points of the ear, they can be stimulated with different forms, such as needles, electricity, laser, or acupressure (applying pressure using fingers, knuckles, or dull objects like magnet beads or vaccaria seeds), (Asher et al, 2010, Round et al, 2013). Investigations involving the auriculotherapy have demonstrated beneficial effects in various undesirable clinical conditions (Suen et al, 2001, Suen et al, 2002, Gori and Firenzuoli, 2007, Giaponesi and Leão, 2009, Round et al, 2013), such as pain and anxiety (Sator-Katzenschalger and Michalek-Sauberger, 2007, Asher et al, 2010), pain associated with cancer (Alimi et al, 2003), knee arthroscopy, (Usichenko et al, 2007), hip fracture and hip arthroplasty (Usichenko et al, 2005). Auricular acupuncture has also been used for the treatment of verruca plana or flat warts in a randomized work. Studies have suggested that auricular acupuncture alone can relieve pain and anxiety in the pre-hospital transport phase of hip fracture (Usichenko et al, 2005, Barker et al, 2006), reduce acute pain due to a variety of causes in the emergency department setting (Goertz et al, 2006), and in patient with cancer (Alimi et al, 2003). A systematic review of auriculotherapy for peri-operative pain has concluded its efficacy (Usichenko et al, 2008).

Surface electromyogram (EMG), has been used in the investigation of muscular function in various types of analysis, such as in muscular biomechanics (Finley et al., 2005, Barack et al, 2006), muscular skeleton fatigue (Ebaugh et al., 2006), strength (Kamibayashi and Muro, 2006), rehabilitation (Barak et al., 2006) and neuromuscular disorders (Hogrel, 2005). It can also provide a representation of the global level of muscle activity (Ryait et al, 2011). In addition, the surface EMGs can also be used in correlating the electrical activity of the striated skeletal muscles with acupuncture points (Fragoso and Ferreira, 2012, Polliti et al, 2010). Hence, it can be used as a reliable tool to validate some of the effects in acupuncture.

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The purpose of this study is to check if specific regions of the ears can exert influence on peripheral limbs and setup the foundation for the French auriculotherapy. To achieve that goal, a region between the points of elbow and shoulder in the scaphoid fossa was chosen to see if the electromyographic response of the *biceps brachii* muscle would respond to the stimulation of such a region. If the experimental outcome turns out to be positive, then to a larger context, it would definitely permit us to speculate that the French auriculotherapy could be derived from the same principle as that of the Chinese acupuncture via the chaotic wave theory of fractal continuum.

Materials and Methods

Subjects in the Case Report

Two subjects participated in the present pilot study, i.e., a man (32 years, 186 cm, 91 kg), and a woman (29 years, 166 cm, 58 kg). Both participants were physically active and experienced with free-weight resistance exercises and training leading to failure. Prior to data collection, participants were informed of the requirements associated with participation and provided written informed consent. Participants were encouraged to maintain their dietary, sleeping, and drinking habits during participation of this study. The research project was conducted according to the Declaration of Helsinki and was approved by the University Review Board for use of Human Subjects.

Surface EMGs (sEMG)

Muscle activities of the *biceps brachii* (BB) muscle were measured using sEMG. Prior to electrode placement, the area was shaved and cleaned with isopropyl alcohol to reduce skin impedance. The electrodes were placed over the mid-belly of the muscle parallel to the direction of the fibers according to recommendations by the SENIAM project (Surface Electromyography for the Non-Invasive Assessment of Muscles) (Hermens et al, 2000). The position of the surface electrode is illustrated in Figure 1.

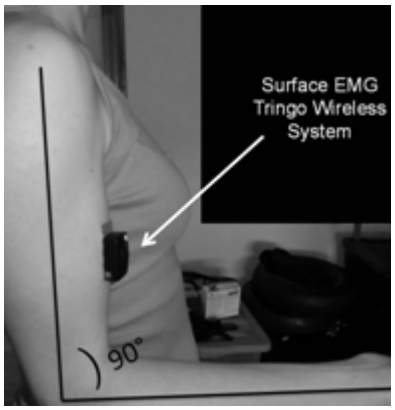

Figure 1: Position of the surface electrode on the mid-belly of *biceps brachii* muscle

The double differential technique was used to detect myoelectric raw signals. The surface electrodes were connected to a 16-bit AD converter (TrigoTM Wireless System, Delsys Inc., Boston, MA, USA). Raw EMG signals were pre-amplified close to the electrodes (signal bandwidth of 20-450 Hz) and sampled at 4000 Hz and stored on a laptop. The sEMG data analysis was performed using specific software (Delsys EMGworks Analysis 4.0. Delsys Inc. Boston, Massachusetts, USA). Then, the sEMG data was averaged by root mean square (rms) in order to obtain averaged amplitude of the sEMG signal.

Stimulation with the Finger of a Region Related to Biceps Braquii Muscle

In order to verify the hypothesized mechanism of auriculotherapy, we used points in the scaphoid fossa which represents the region of

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elbow and shoulder, as proposed by Nogier, 2009 (Figure 2).

During the experiments, the individuals remained standing. Before beginning the recording of sEMG, each subject was asked to carry out a series of three maximum isometric contraction of the arm. Verbal encouragement was given to the subject especially during the task. Mean muscle output was used to determine maximum voluntary isometric contraction (MVIC), as it was believed to be a more accurate representation of a subject's strength than a single contraction. MVIC parameters of each treatment were monitored by a digital load cell HCB (Kern & Shon GmbH, Balingen, Germany).

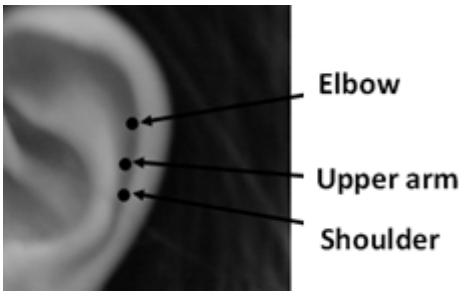

Figure 2: Acupoints of the ear used in this study.

Due to the nature of case report, the same volunteers also served as control. Consequently, each subject performed the three treatments, i.e., control, sham, and acupressure, in random order. A rest of 10 min was allowed between treatments. The results obtained with the acupressure with the fingers on the points specific to the arm region, were assigned as the experimental group and the placebo group served as control. EMG signals were recorded for these three distinct conditions. The duration of each EMG signal sample was 5 s.

Acupressure with Fingers on the Points of the Ear

In the acupressure treatment, acupressure was done with fingers on the points of the ear corresponding to the arm which was located between the fourth (elbow) and the fifth (shoulder) of the seven spaces contained between the posterior fold of the anti-tragus as indicated in Figure 2. As to the sham group, the acupressure is applied on the shell of the ear as sham treatment (see Figure 2), since this region does not present any somatotropic relationship to the arm. In order to make the whole process easier to understand, the flowchart showing a summary of the study is provided below in Figure 3.

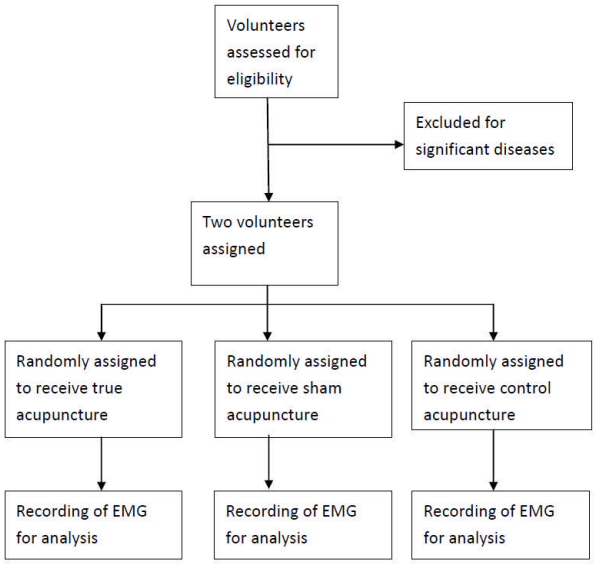

Figure 3: The flowchart showing a summary of the process

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Results

Statistical Analysis

Data are analyzed and presented as means and standard deviations (SD), in Figures 4 and 5. It can be seen from there that the acupressure with finger, i.e., auriculotherapy, on a specific point, can possibly be associated with a somatopic response to the *biceps brachii* muscle. Moreover, in a man, auriculotherapy can modify the response of the EMG associated with the muscle while the response of the acupressure of a sham point has a different response. In the mean time, the MVIC was higher during auriculotherapy (auri) treatment than control and sham treatments for both subjects.

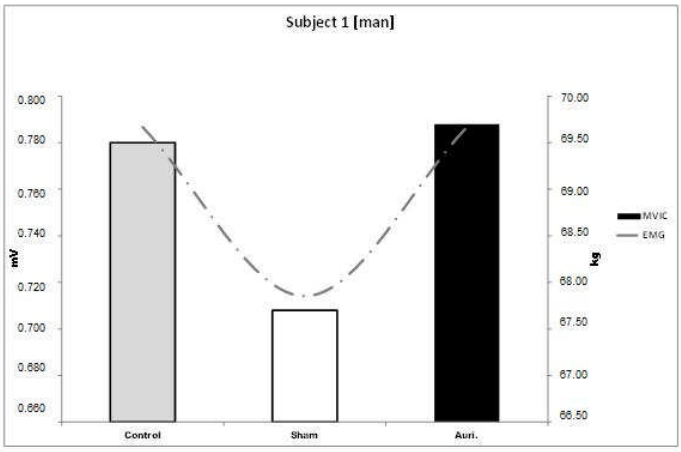

Figure 4: The acute effects of different treatments on EMG rms (mV), and MVIC (kg), [subject 1].

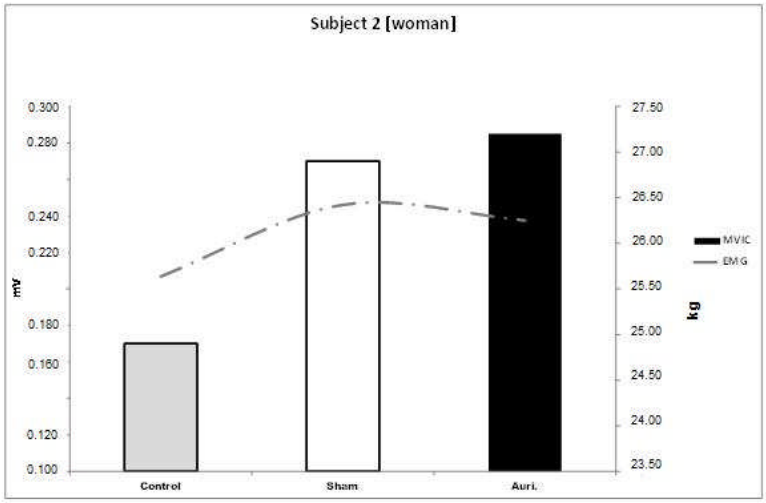

Figure 5: The acute effects of different treatments on EMG rms (mV) and MVIC (kg), [subject 2].

Discussion

The experimental findings presented in Figs. 4 and 5, have shown the effects on the surface EMGs in treated, sham, and control experiments. The amplitude of EMG is roughly proportional to the force exerted by the underlying muscle. This relationship can be appreciated

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from Figs. 4 and 5. Our findings are in agreement with that of Politti et al, 2010, that have demonstrated the surface electromyography can be used as a tool to investigate possible alterations of electrical activity in muscles after auricular acupuncture. They have also found an increase of the root mean square (RMS), amplitude in the upper trapezium muscle at 60% MVIC, after 5 min of the insertion of the acupuncture needle in the ear. Moreover, no statistically significant differences were found in the analysis of the trapezium muscle in the placebo group. In addition, Ryait et al, 2011 have also demonstrated the importance of the surface EMG in studies involving the acupressure of acupoints of the meridians.

From our experimental results, we have confirmed the fact that correlation indeed exists between the auricular region in the ear and the peripheral limbs of the body. According to the chaotic wave theory of fractal continuum, the meridian system is a network of neurovascular bundle with its smaller branches that will connect the internal organs, peripheral limbs and sensory organs. Hence, the sensory organs are actually interconnected with peripheral limbs and visceral organs via the neurovascular bundles. Due to interconnectedness, the sensory organ of the ears can interact with the limbs and organs. Hence, it is proper and fitting to conjecture that the auriculotherapy has exerted its influence on peripheral limbs. Experimental findings presented in Figs. 4 and 5, have shown the effects on the surface EMGs in treated, sham, and control experiments.

The mechanism of French auriculotherapy can be alluded to the impedance change after acupressure so that its influence will be propagated to the correlated area or region of the body. It is certainly important and interesting to study in the future if auriculotherapy can be helpful for the visceral disorders via the same idea. To sum up, using the chaotic wave theory of fractal continuum, it is possible to unify the mechanism of French auriculotherapy and that of Traditional Chinese acupuncture at the same time.

Conclusion

In conclusion, although there is a limitation in this case report due to the number of subjects, the analysis of our findings reported in this investigation permits us to speculate that the stimulation with fingers, i.e., acupressure, of region between the points of elbow and shoulder in the scaphoid fossa of the auricular pavilion presents an electromyographic response related to the *biceps brachii* muscle. Hence, the mechanism of French auriculotherapy could be very well derived from the same principle of that in the Chinese acupuncture mechanism of therapeutics. Both mechanisms could be attributed to the chaotic neurovascular flow of the meridian system which has a self-similar structure of fractal continuum. Hence, the human body is an integrated whole and should be treated as such. In addition, it is hoped that the findings reported in this case study can increase our clinical knowledge and understanding about the auricular acupuncture.

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