Modernization of Acupuncture Education and Research
Including contributions to COVID-19

Edited by
Gerhard Litscher
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Special Issue Editor

Gerhard Litscher
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About the Special Issue Editor

Gerhard LITSCHER, Univ.-Prof. Prof. hc mult. MSc PhD MDsc, is Head of the Research Unit for Complementary and Integrative Laser Medicine, of the Research Unit of Biomedical Engineering in Anesthesia and Intensive Care Medicine and Chairman of the TCM (Traditional Chinese Medicine) Research Center at the Medical University of Graz, Austria, Europe. He is a Doctor of Technical Sciences and Doctor of Medical Sciences and has published approximately 600 scientific papers (>230 SCI/PubMed-listed). He is the author and/or editor of 17 books and editor and/or editorial board member of more than 35 international journals. He is founding editor and editor-in-chief of OBM Integrative and Complementary Medicine. Gerhard Litscher is also President of the International Society for Medical Laser Applications (ISLA transcontinental, since 2012), German Vice President of the German-Chinese Research Foundation (DCFG, since 2014), and Chairman of Consensus Guidelines for Laser Acupuncture of the World Association for photobiomoduLation Therapy (WALT). He is a member of the expert panels of the World Health Organization (WHO) for acupuncture and related fields, and is currently honorary or guest professor at 12 top universities and institutions in China.
Preface to “Modernization of Acupuncture Education and Research”

This book focuses on the latest innovative aspects concerning modernization of acupuncture. Altogether, 10 manuscripts underwent a peer-review process. Some of the chapters report results of acupuncture in combination with different modalities (manual needle acupuncture, laser acupuncture, electroacupuncture, ear acupuncture etc.). Data from patients, healthy volunteers and animals were evaluated and are presented in this book.

Integrative and Complementary Medicine (ICM), including Traditional Chinese Medicine (TCM) with acupuncture, has proven to be effective also in the rehabilitation of COVID-19 (Coronavirus Disease 2019) patients. The present moment lacks any reliable vaccine or treatment for the SARS-CoV-2 virus and the resultant disease COVID-19. Laser medicine like photobiomodulation (PBM) or photodynamic therapy (PDT), and laser acupuncture may possess some potential to interact and relieve the symptoms of this disease. The first two chapters (editorials) are dealing with this question. In chapter three, we present for the first time a newly developed multimodal light-emitting diode (LED) pad for photobiomodulation (PBM). There are very few scientific publications on acupuncture and its gender-specific effects. Chapter four summarizes the previous work from the perspective of both Western and Eastern medicine, involving manual acupuncture, electro-acupuncture, and modern innovative laser acupuncture. There is scientific evidence that future gender-specific considerations should be included in the assessment of acupuncture therapy success. Chapter five aimed to investigate the short-term effects of heart rate variability and heart rate, during and after the acupuncture needle stimulation in patients with lower back pain. The treatment by auricular therapy has a long history. Ear acupoint research has been advancing step by step worldwide. Chapters six and seven are dealing with this question including dynamic pulse reaction. Chapter 8 shows modulation of excitability of spinal neural functions by acupoint stimulation physical therapy at lung 5 acupoint in three hemiplegic patients with cerebrovascular disease and chapter 9 an increase in electrodermal activity on acupuncture points of lymphatic, lung, nervous, endocrine and heart meridians after running exercise. The last chapter, chapter ten deals with some important aspects of TCM education and practice in Europe and China.

It is a great honour to be academic editor for this special issue. I wish to thank the publisher for this excellent opportunity to serve the research community. I am also grateful for the hard work and support provided by the editorial office in China, especially Mrs. Kelley Zhang and Mrs. Karen Li, and the USA to make the project a success. A big thank you to all authors for their contributions. To the readers, thank you for your interest.

May 2020

Gerhard Litscher

Medical University of Graz
Editorial

COVID-19 (Coronavirus Disease-19): Traditional Chinese Medicine including Acupuncture for Alleviation – A Report from Wuhan, Hubei Province in China

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Abstract

Traditional Chinese Medicine (TCM) has been used to prevent and alleviate epidemic diseases for hundreds of years. The combination of TCM and Western medicine can effectively reduce fever; alleviate cough, fatigue, diarrhoea and other symptoms of patients with mild COVID-19 (Coronavirus disease-19). For the treatment of moderate and severe syndromes, the integrative approach can reduce lung exudation and inhibit the further development of the disease. However the risk of infection is a limit for example in needle acupuncture treatment. Computer-controlled laser acupuncture and/or robot-controlled acupuncture are nowadays not far away from clinical use.

Keywords

COVID-19 (Coronavirus disease); Novel Coronavirus Pneumonia (NCP); Traditional Chinese Medicine (TCM); acupuncture; laser acupuncture; robot-controlled acupuncture

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1. Introduction

One important thing in advance: With acupuncture you will not be able to cure coronavirus disease (COVID-19). However, it seems appropriate to report on different strategies in which symptoms can be alleviated, as is currently (February 25, 2020) practiced in Wuhan in Hubei Province in China.

“Coronavirus infections in China continue to swell by thousands a day, prompting epidemiologists to estimate when the outbreak will peak. Some suggest the climax, when the number of new infections in a single day reaches its highest point, will happen any time now. Others say that it is months away and that the virus will infect millions — or in one estimate hundreds of millions — of people first.”[1].

Traditional Chinese Medicine (TCM) has been used to prevent and alleviate epidemic diseases for hundreds of years. Smallpox prevention in China was an epoch-making initiative in the history of human preventive medicine. Several editions of ‘The Diagnosis and Treatment Plan for Novel Coronavirus Pneumonia (NCP)’ (COVID-19) have been issued by the National Health Committee of China. The plan fully attaches importance to the diagnosis and treatment of integrated Traditional Chinese and Western medicine, effectively guiding clinical treatment work, especially emphasizing the role of Chinese medicine, and establishing a consultation system of integrated Traditional Chinese and Western medicine. All over the country, effective treatment of COVID-19 with integrated Chinese and Western medicine has been carried out. There are also specialized scientific research institutions, hospitals and enterprises to jointly carry out online consultation of TCM experts for COVID-19 patients [2, 3].

2. Application of TCM

The ‘National Plan’ guides the clinical practice of TCM treatment as early as possible, reducing fever, improving cough, asthma and gastrointestinal symptoms in time and effectively, and improving the cure rate. The combination of TCM and Western medicine can effectively alleviate the fever, cough, fatigue, diarrhoea and other symptoms of patients with mild NCP. For the treatment of moderate and severe patients, the integrative treatment can reduce lung exudation and inhibit the further development of the disease.

3. Application of Acupuncture and Moxibustion

Acupuncture and moxibustion are important parts of TCM. Historically, burning moxa leaves and moxibustion on acupoints (purulent moxibustion) have been used to prevent epidemics. Moxibustion, through the stimulation of warming acupoints, has the functions of warming yang, dispersing cold, activating meridians, strengthening yang and removing toxin, etc. Modern research on moxibustion has disclosed its obvious effect in regulating immune function and autonomic nervous system [4].

For further COVID-19 prevention, diagnosis and medical treatment, China Association of Acupuncture-Moxibustion (CAAM), as a group member of the World Federation of Acupuncture - Moxibustion Societies (WFAS) has organized acupuncture and moxibustion experts to work
immediately, and has formed a group of experts for the prevention and control of the COVID-19. The group has formulated and published Guidelines on Acupuncture and Moxibustion Intervention for Novel Coronavirus Pneumonia (first edition).

Although some research showed that there are antiviral components in moxa, the influence of smoke will be considered when it is used in the closed environment of the isolation ward, so acupuncture point application, pressing pills on ear acupuncture points, acupoint pressing and massage, etc. are more widely used in the practice. The commonly recommended acupoints for moxibustion and acupoint application are Zusanli (ST36), Guanyuan (CV4), Dazhui (GV14), Fengmen (BL12) and Feishu (BL13), other acupoints such as Zhongwan (CV12) and Shenque (CV8) are applied according to the symptoms. The acupoint therapy improves the symptoms such as poor appetite, coughing, insomnia, headache of the COVID-19 patients effectively [5].

4. Application of Qigong

China has built up to now (February 25, 2020) more than a dozen of temporary shelter hospitals in Wuhan to treat the patients with mild COVID-19. Some of the patients exercise Qigong under the guidance of doctors [6]. Qigong can improve the pain situation throughout and fatigue of the COVID-19 patients.

5. New Technologies in Acupuncture Research

Although TCM can be used sensibly for COVID-19 [7], traditional needle acupuncture has some limitations. In this special situation, there is the risk of infection as well as practical handling. There are already alternatives for both. Computer-controlled laser acupuncture is one of the possibilities [8] and robot-controlled acupuncture [9] is nowadays not far from clinical use. This vision of “robot-controlled acupuncture” is already a reality [9] as one of the authors (G.L.) has been reported on the ‘Binhu lecture’ in Wuhan on September 19, 2019 [10].

Acknowledgments

The article has been drafted as cooperative report in Wuhan and additional parts and current literature have been added from the author from Graz. Professor Fengxia Liang is Director of the Institute of Acupuncture and Moxibustion of the Hubei University of Chinese Medicine in Wuhan, China. She has been Visiting Scientist at the Medical University of Graz in Austria in 2017. Professor Gerhard Litscher is also Visiting and Honorary Professor at Hubei University of Chinese Medicine in Wuhan, China and at Hubei Provincial Collaborative Innovation Center of Preventive Treatment by Acupuncture & Moxibustion, Wuhan, China, respectively.

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Competing Interests

The authors have declared that no competing interests exist.
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Can Laser Medicine and Laser Acupuncture be used for COVID-19? 
Selected Areas of the Current Scientific Literature

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Academic Editor: Gerhard Litscher

Special Issue: Modernization of Acupuncture Education and Research

Abstract

The present moment lacks any reliable vaccine or treatment for the SARS-CoV-2 virus and the resultant disease COVID-19 (Corona Virus Disease-2019). Laser medicine like photobiomodulation (PBM) or photodynamic therapy (PDT), and laser acupuncture may possess some potential to interact and relieve the symptoms of this disease. PubMed lists only two results for the search term ‘PBM or PDT and COVID-19’, indicating the paucity of validated scientific clinical studies on the subject. On the contrary, it does not mean that the laser does not have any effect on COVID-19. The development of therapeutic procedures will continue to play a major role in COVID-19 in the future.

Keywords

COVID-19 (Coronavirus disease - 2019); SARS-CoV-2 virus; photobiomodulation (PBM); photodynamic therapy (PDT); laser acupuncture
1. Introduction

Integrative and Complementary Medicine (ICM), including Traditional Chinese Medicine (TCM) with acupuncture, has proven to be effective in the rehabilitation of COVID-19 (Coronavirus Disease 2019) patients [1–5].

Appropriate expert teams have been authorized to manage rehabilitation treatments using TCM and the combination of TCM and Western medicine across China [4]. In February 2020, Chinese health authorities issued a guide for the use of TCM in recovered patients, which includes TCM recipes, nutritional advice, moxibustion, cupping, acupuncture, and music therapies, as well as traditional exercises like Tai Chi or Qi Gong [6].

2. Application of Photobiomodulation (PBM) and Laser Acupuncture (LA)

As on 30th April 2020, the most widely used medical database PubMed indexes only two results for the search ‘PBM or photodynamic therapy (PDT) and COVID-19’, which included a letter to the editor and a guest editorial [7, 8]. This indicated the fact that no validated scientific studies have been carried out on the subject. However, it nowhere denies the role of lasers on COVID-19. Scientific societies that deal with the topic, therefore, find it very difficult to recommend guidelines for adequate treatment or alleviation. A careful interpretation of the two articles [7, 8] presents great potential for relatively new methods in the area of integrative medicine. Nevertheless, hurried conclusions need to be avoided.

Dominguez et al. [7], in a letter to the editor entitled ‘Can transdermal photobiomodulation help us at the time of COVID-19?’, describe various possibilities of the non-invasive laser blood irradiation, which has already been used in numerous areas in Russia and Germany [9,10]. Unfortunately, the authors are unable to pinpoint any confirmed results in connection with COVID-19. On 24th April 2020, they documented, among other things, “We recommend the identification and treatment of hyper inflammation using a non-invasive therapy that exists with proven safety profiles to address the immediate need to reduce the rising mortality by performing projects that include transdermal PBM with application to 30 min per day for 3–5 days with diode laser whether visible or invisible” [7].

Fekrazad cites a good overview of PBM and COVID-19 in a guest editorial in the same journal ‘Photobiomodulation, Photomedicine, and Laser Surgery’ on 23rd April 2020 [8]. He describes the possibilities of PBM and antiviral PDT as a potential novel approach in COVID-19 management. He asserts, “Of course, in the future, the use of a different modality of PBM and PDT can be evolved and, by using monoclonal antibodies, we could target lung tissue specifically. It can even be improved by using nanotechnology, making new photosensitizers in Nano scales, and pasting them to the target tissues to obtain better results.” [8].

The scientific literature on laser medicine presents promising approaches worldwide with regard to attempts at controlling bacterial and viral infections in humans, although no such evidence on containment of COVID-19 is available. Exemplarily, in 2018, Kingsley et al. [11] in the USA investigated the potential of visible monochromatic violet/blue light (405 nm) as a nonthermal intervention for viruses on foods like berries that are prone to norovirus contamination. The authors showed that the use of food-grade singlet oxygen enhancer compounds in combination with light in the visible spectrum might offer a means to inactivate foodborne viruses.
Another study from Iran investigated the effects of riboflavin (RB) in combination with different doses of ultraviolet light (UV) on platelet concentrate (PC), which was infected by three models of the virus [12]. The study indicated that RB/UV treatment proved to be a promising pathogen reduction technique in PC and had limited effects on platelet quality [12].

One study from Australia [13] demonstrated that treatment with RB and UV light decreases dengue virus (DENV 1-4) titers moderately.

Authors from Sweden in 2019 [14] stated that a high dose of blue light could perhaps treat bacterial infections without any loss of human skin cells. They indicated that PDT using riboflavin and blue light should be explored further as it may be utilized in the treatment of skin diseases associated with keratinocyte hyperproliferation. In 2014, researchers from Beijing [15] developed a flow-based treatment device using RB and UV light to inactivate viruses in fresh-frozen plasma (FFP) and demonstrated an enhanced efficiency of the virus inactivation, although the total activity of plasma factors was reduced.

Risk reduction strategies for transfusion-related acute lung injury (TRALI) involve the preferential use of male donors in providing FFP [16]. Authors from Spain thanked its readiness, simplicity, and feasibility, which facilitated the implementation of riboflavin- and UV light-treated FFP, and thus the TRALI prevention strategy with ease [16].

In 2018, two authors from the UK [17] reported in a perspective article that blue light undoubtedly had the potential to become a highly effective antimicrobial. However, the key questions are yet to be answered, including the mechanisms of toxicity and the contribution of porphyrin-independent mechanisms in particular [17].

In 2016, authors from Colorado [18] investigated the efficacy of RB and UV light against Middle East respiratory syndrome coronavirus (MERS-CoV) tested in human plasma and reported that RB and UV light effectively reduced the titers of MERS-CoV in human plasma products to below the detection limits; this suggested that the treatment process may reduce the risk of transfusion-transmission of MERS-CoV.

The available scientific literature includes only two papers to date on LA, in connection with COVID-19 that speak of the potential for it. Fekrazad in 2020 [8] mentioned that more attention must be paid to laser acupuncture. Liang and Litscher 2020 [3] addressed in an editorial, the prospects of robot-controlled (laser) acupuncture in correlation with highly infectious diseases [19]. The recommended acupoints for moxibustion and needle acupoint application include Zusanli (ST 36), Guanyuan (CV 4), Dazhui (GV 14), Fengmen (BL 12), Feishu (BL 13), Zhongwan (CV 12), and Shenque (CV8). The same points can be used in laser acupuncture. Acupuncture reduced poor appetite, coughing, insomnia, and headaches in patients with COVID-19 [3–5].

3. Future Aspects

The development of therapeutic procedures will continue to play a major role in COVID-19 in the future, especially since consistent containment of SARS-CoV-2 currently appears to be the only sensible strategy from an epidemiological viewpoint. Other strategies, such as rapid infection control or eradication of the virus, are currently impractical and unsuccessful.

Attempting to establish rapid herd immunity does not make sense because it is not yet known how long people will be immune after surviving an infection with the coronavirus. This is also because the approach of the epidemic ultimately builds on the idea that infected people will live
for years and afterward become immune. In addition, an infection is not recommended because the long-term effects of COVID-19 on organs like the lungs and heart have not yet been ascertained.

4. Conclusions

PBM and PDT are very interesting and promising approaches to the treatment of various diseases. However, the literature lacks research on PBM and related methods like LA and COVID-19. Out of the available scientific literature on these topics, most are speculating, while robust clinical trials are completely missing.

Author Contributions

GL wrote the article during telework.

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Competing Interests

The author has declared that no competing interests exist.

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Technical Note

Efficacy of LED Infrared Warming in the Periphery of the Human Body – First Investigations in a Subject using Thermography

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Academic Editor: Im Quah-Smith

Special Issue: Modernization of Acupuncture Education and Research

Abstract

In this technical report, we present for the first time a newly developed multimodal light-emitting diode (LED) pad for photobiomodulation (PBM). In order to demonstrate the range of possibilities for its application, we carried out a comparison of measurements with and without infrared (IR) LEDs in a volunteer, and are presenting the results. The pad consists of several components, which are mainly composed of LEDs of different modalities (IR, red, yellow, and blue). This multicolor system was applied to a peripheral area of the body in the volunteer. Thermal imaging of the region of interest showed that additional stimulation with IR LEDs increased temperature by about 113% compared to stimulation without IR LEDs. Our results concluded that non-visible IR LED stimulation techniques could be extremely helpful in improving the quality of PBM.

Keywords
Photobiomodulation; LED (light-emitting diode) pad; thermography; thermal imaging; infrared LED; red LED; yellow LED; blue LED; peripheral effects

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1. Introduction

An infrared (IR) LED (light-emitting diode) is a special diode, which emits light in the near-infrared wavelength at a range of 700 nm to 1000 nm. This area of the light spectrum is not visible to the human eye but can be measured with radiation detectors like photodiodes and phototransistors. It is less known that IR LEDs were the first LEDs to be produced, and were developed even before the first red light-emitting diodes. In 1961, Robert Biard and Gary Pittman patented the first gallium arsenide (GaAs)-based infrared LED produced at Texas Instruments [1]. Until the early 1970s, the only available LEDs – red and infrared LEDs – were very expensive. In comparison, the current price of a large quantity of IR LEDs is very low. Infrared LEDs are manufactured with different wavelengths.

Human body stimulation with different optical modalities (including IR LEDs) is a novel form of non-invasive photobiomodulation (PBM), and it has shown therapeutic potential in a variety of conditions [2, 3]. Such a method can be combined with non-invasive LED stimulation using other wavelengths (e.g., the use of red, yellow, or blue LEDs).

The present article outlines the development and first-time application of a new phototherapy pad applied to the peripheral area of a human volunteer. Non-invasive thermal imaging was used to investigate the temperature alterations of the skin from the new stimulation method [4].

2. Methods

2.1 Phototherapeutic Pad

A new phototherapeutic pad (Suyzeko, Shenzhen, China) based on polychromatic light therapy is being presented for the first time in a scientific article here. The possible values of measurement for treatment in a volunteer are also briefly shown. The pad consists of several components, which are mainly composed of LEDs of different modalities (IR, red, yellow, and blue). This multicolor system can be applied to any area of the body. The system consists of two pieces of pads, a control unit, a power adaptor, a power cable, and a manual (see Figure 1).

Figure 1 Phototherapeutic pad using different modalities of LEDs (Suyzeko, Shenzhen, China). The picture shows an example of the application on the hand, but only measurements on the feet were carried out for the experiments in this work.
The following LEDs are integrated into the system and can be controlled and activated both individually and in various combinations through the control unit: IR, red, yellow, and blue (see Figure 2 and Table 1). The geometrical dimensions of each pad are 28.3 x 25.0 cm, with the active area in which the LEDs are integrated being 20 x 17 cm.

![Figure 2 Different colors of the pads.](image)

Table 1 shows the number and wavelength of individual LEDs, the total number of LEDs, and the wavelength range.

<table>
<thead>
<tr>
<th>LED (light-emitting diodes)</th>
<th>Pieces</th>
<th>Wavelength (nm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infrared</td>
<td>84</td>
<td>810</td>
</tr>
<tr>
<td>Red</td>
<td>70</td>
<td>660</td>
</tr>
<tr>
<td>Yellow</td>
<td>28</td>
<td>589</td>
</tr>
<tr>
<td>Blue</td>
<td>28</td>
<td>405</td>
</tr>
<tr>
<td>Total number/range</td>
<td>210</td>
<td>405 – 810</td>
</tr>
</tbody>
</table>

The intensity of each LED was 0.2 W. The spectral power density was not specified by the manufacturer. Unless an infrared filter is installed, digital cameras are usually sensitive to both visible light and infrared light. With the help of active IR LED pads, the functionality of infrared remote controls can easily be checked (Figure 3).
2.2 Experiment, Volunteer and Procedure

A 61-year-old male volunteer subject was given stimulation using the new phototherapy pad, and monitored before, during, and after stimulation by thermal imaging. The volunteer neither had any neurological, cardiovascular, or respiratory diseases, nor was taking any medication at the time of examination. The experiment, which included only non-invasive measurement methods (LED stimulation and thermography), was approved by the local ethics committee of the Medical University of Graz, and the measurements were performed according to the declaration of Helsinki.

Before receiving the stimulation, the volunteer sat for 5 min on a chair to adapt to the room conditions (temperature). Then, thermal images of the region of interest were taken 5 min before, every 5 min during, and 3 min after stimulation. Thermal images of the same locations were taken at the end of the stimulation process. Figure 4 shows the experimental flow chart.

![Figure 4](image)

**Figure 4** Experimental procedure (measurement points: before stimulation, every 5 minutes during stimulation (5 – 60 min), and 3 minutes after stimulation.

The experimental procedure consisted of collecting two sets of measurements, which was carried out on two different days in almost the same manner, at the same time of the day and on the same person (also same room temperature of 23.3 °C; same humidity of 55%). The only difference between the two sets of measurements was that an additional 84 invisible infrared
LEDs (810 nm) were activated in the second set of measurements. The aim was to determine any possible differences in the evaluation parameters (temperature changes).

2.3. Thermal Imaging and Data Analysis

Thermal imaging was performed using an infrared camera Flir i7 (Flir Systems Inc., Portland, USA). This imaging technology allows the simultaneous measurement of temperatures at multiple points on the surface of the skin, and also acts as a reference for the surrounding temperature. The camera operates at a wavelength range of 7.5–13 µm. The focal distance of the infrared lens is f = 6.8 mm. The infrared resolution is 140 x 140 pixels, and the accuracy of the camera lies at ±2% of the reading. The data were transferred to a notebook (Acer, Aspire 5, Acer Inc., Taipei, Taiwan) using Flir Tools software (April 2020, Flir Systems Inc., Portland, USA). Thermal images for evaluating temperature changes in the volunteer were taken 5 min before, during (at 5-minute intervals), and 3 min after stimulation. The region of analysis for the thermographic measurements included areas around the right side of the right foot of the volunteer (1 cm diameter of the region of interest: see cursor in Figures 5 and 6). In these areas, the highest temperature value was marked (see cursor in Figures 5 and 6).

3. Results

Figure 5 shows the results of the thermal images taken before, during (5 to 60 min), and after continuous red, yellow, and blue LED stimulation via the new pad. The measurement point with the highest increase in temperature (see cursor) was found at the end (60 min) of continuous stimulation (28.8 °C).

Figure 5 Thermal images. Note the increase in the temperature in the region of interest during continuous and simultaneous red, yellow, and blue LED stimulation.

Figure 6 shows the results of the thermal images taken during the second set of measurements in the same person. Again, continuous red, yellow, and blue LED stimulation was carried out. In addition, 84 non-visible infrared LEDs were activated. The highest increase in temperature in this session was also found at the end (60 min) of continuous multimodal stimulation (30.2 °C).
Figure 6 Thermal images. Note the high increase in the temperature in the region of interest during continuous and simultaneous infrared, red, yellow, and blue LED stimulation.

As shown in Figure 7, the use of IR LEDs had a striking effect in the results, which showed that despite similar test conditions, there was a significant increase in the temperature in the area of the subject's foot. On quantifying this effect, the measurement temperature was found to increase by about 113% compared to stimulation without using IR LEDs. The five-minute timepoint was used as a baseline because, at this point, the temperature differences between the two experiments were nearly equal (Figure 7).

Figure 7 Temperature behavior at the measuring point of the subject's right foot. Note the significantly increased effect under the stimulation condition with the activated IR LEDs.
4. Discussion

This short technical report outlines a new non-invasive LED method for PBM that can be used for peripheral stimulation of the human skin.

The results of an animal experiment conducted recently in 2020 showed that infrared LED had significant effects on mechanical stimulation and cold allodynia. In the spared nerve injury (SNI) model of rat, an analgesic effect was observed after every treatment. However, the effect was abolished when treatment was interrupted. These findings by authors from Brazil suggest that PBM therapy may be useful as an adjunct therapy for chronic pain [5].

A study by Gavish et al. published recently in 2020 [6] showed that near-infrared PBM was found to induce a 27% increase in microcirculatory flow that increased to 54% during a 20-minute follow-up period, but red light PBM did not show a similar increase in median flow. Only ten out of twenty participants were responsive to PBM, as shown by thermal imaging. The authors demonstrated the underlying mechanism in which PBM induces arteriolar vasodilation resulting in both immediate and long-lasting increased capillary flow and tissue perfusion in healthy individuals. This response was found to be wavelength-dependent and modified by skin temperature [6].

Another study dealt with chronic obstructive pulmonary disease (COPD), which is characterized by dyspnea as well as musculoskeletal and systemic manifestations. PBM, along with light-emitting diode therapy, is an intervention that has been found to minimize or delay muscle fatigue. The aim of the study [7] was to evaluate the (acute) effects of PBMT when used in combination with laser diodes, LEDs, or magnetic field on muscle performance, exercise tolerance, and metabolic variables during a 6-minute step test in patients with COPD. The study showed that the combined application of PBM therapy and magnetic field increased the number of steps during the step test, and decreased the sensation of dyspnea and lower limb fatigue in patients with COPD [7].

The efficacy of infrared warming therapy is well known. In 1999, Mori et al. [8] showed the effects of warming the eyelids with an infrared heater in comparison with a broad-spectrum heater. The authors concluded that heating for only 5 min was necessary to increase ocular temperature and enhance comfort. In our present study, we could not show a similar immediate effect after heat stimulation for 5 min; however, this could be attributed to the fact that the technical parameters of stimulation and also the site of stimulation were very different in our study.

In our pilot investigation in a volunteer subject, the peripheral temperature was significantly increased with the use of infrared LEDs compared to the same procedure done without infrared LEDs. Additionally, the warming effect of the feeds was significantly more pronounced after using our innovative pad with infrared LEDs for the longest stimulation time (60 min) than with the use of red, yellow, and blue LEDs alone.

According to Figures 5 and 6, the pad itself heated up during the irradiation, and remained hot after the irradiation, in both cases when red LEDs were used, and when infrared LEDs were added. In addition, temperature changes in the left leg were minor, whereas the right leg underwent a more pronounced temperature elevation. A possible reason for this could be a knee injury on the right leg of the volunteer, which may have been trained more in the previous months than the left one.
In this pilot study, we have used infrared thermography as an evaluation method. It is a suitable method to quantify surface temperature changes. In the future, we want to use Laser Doppler imaging (LDI) to record any changes in microcirculation, as has already been done in similar studies in the past [6, 9-14]. The use of near-infrared photobiomodulation to increase microcirculatory blood flow, as measured by a variety of techniques including laser Doppler, was demonstrated by Gavish et al. [6], Samoilova et al. [9, 10], Schindl et al. [11, 12], Schaffer et al. [13], and Litscher et al. [14]. The effects of near IR PBM include the optimization of mitochondrial function, decrease in fatigue, and improvement of peripheral circulation [6, 9-14].

This study has several limitations. IR light can penetrate the skin and deep tissues. If patients use IR for a prolonged period of time, it may change their core temperature. Therefore, an important safety measure to be followed is to ensure that the patients do not experience hyperthermia. In our experiments, the core temperature was not recorded, which is a limitation of this study.

Due to the addition of 84 IR LEDs to the LED pad, the second experiment produced more heat in the patient’s feet than the first one. Therefore, the second session had more LEDs than the first session making a direct comparison between the two sessions unequal. Another limitation of the study is that the volunteer did not have the same baseline temperature of the feet before stimulation in the two sessions.

Studies with a larger number of cases with corresponding clinical pictures are planned for future work, in order to justify or exclude possible clinical uses of the new LED pads.

5. Conclusion

In this technical report, we present a new LED pad for PBM. Through our study, we were able to show that stimulation with different modalities of LEDs resulted in different biological thermographic effects. This indicates that in addition to continuous and simultaneous red, yellow, and blue LED stimulation, non-visible infrared LED stimulation techniques may be helpful in improving the quality of PBM; however, this has to be proven further in future research.

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Author Contributions

GL designed and performed the pilot measurements and wrote the article.

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Competing Interests

The author has declared that no competing interests exist.
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Editorial

Gender Differences in Manual, Electro, and Laser Acupuncture

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Abstract

Acupuncture, being a unique method, is a millennia-old tradition in the field of Chinese medicine. However, it is surprising that there are very few scientific publications on acupuncture and its gender-specific effects. This article summarizes the previous work from the perspective of both Western and Eastern medicine, involving manual acupuncture, electro-acupuncture, and modern innovative laser acupuncture. There is scientific evidence that future gender-specific considerations should be included in the assessment of acupuncture therapy success. Thus this topic is interesting and provides leads for future research to the international research community.

Keywords

Acupuncture; gender; sex; manual acupuncture; electro acupuncture; laser acupuncture

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1. Introduction

As an integrative part of Traditional Chinese Medicine (TCM), acupuncture therapy has been recognized worldwide and well-developed with the help of new modernized technological methods. There are different methods to stimulate acupoints, which mainly include invasive techniques such as manual acupuncture (MA) and electroacupuncture (EA) and non-invasive techniques like moxibustion and laser acupuncture (LA) [1]. Although there is still debate about optimal kind of stimulation, the non-invasive methods are more acceptable to patients with needle phobia. Acupuncture has a wide range of applications in addition to pain-related conditions. Other nervous system problems and dysfunctional diseases, including but not limited to stroke [2], Alzheimer's disease (AD) [3], insomnia [4], anxiety [5] or depression [6], can also be beneficiated by acupuncture therapy. Painful diseases [7] are strongly affected by gender; women are more sensitive to pain. Moreover, gender has also been considered when assessing the efficacy of pharmacological and non-pharmacological pain interventions. According to the DSM-V (Diagnostic and statistical manual of mental disorders (5th ed.) [8] and ICD–10 (International Statistical Classification–10) [9], AD starts in the middle or old age with a gradual onset, progresses over time and manifests by multiple cognitive deficits. It occurs mainly in females than in males [10]. Parkinson’s disease (PD) is diagnosed by the presence of characteristic and progressive motor abnormalities (i.e., bradykinesia, rigidity, and resting tremor) in the absence of dementia. Although in most patients, cognitive problems often occur over time [8,9]. The ratio of men suffering from PD is more than women (2:1) [11]. Major depressive disorder (MDD) is one of the most prevalent psychiatric disorders. Clinical studies have shown that women are more susceptible to depression. Gender susceptibility to depression has been associated with social, cultural, as well as biological factors [12]. Depression is sexually dimorphic with males and females exhibiting differences in incidence, clinical manifestations, and response to antidepressant therapy [13]. The selection of these conditions is not systematic.

With regard to response to acupuncture therapy and its mechanism of action, there is increasing evidence of variation based on gender. Over a decade, several functional magnetic resonance imaging (fMRI) studies have been conducted and significant differences have been observed between men and women in brain activation following acupuncture intervention [14-16]. Lund and Lundeberg from Karolinska Institute in Sweden stated that the mechanisms underlying these differences between women and men in acupuncture are currently unknown but are complex and involve interactions between biological, sociocultural and psychological aspects [17]. Only a few relevant studies related to gender-specific differences in the field of acupuncture are available. Thus one should not neglect the problem [18] but intensify research in this field to develop tailor treatment to meet specific needs for male and female patients, respectively. In this editorial, we reviewed the influence of gender on the efficacy of different acupoint stimulation techniques in the treatment of various diseases and discussed the mechanisms influencing these differences.

2. Search Strategy

The authors conducted a database search in the two most critical scientific databases, PubMed and China National Knowledge Infrastructure (CNKI), the latter is currently the most significant academic journal database in China. The keywords used for the search were “gender”, “gender
difference”, “sex”, “sex difference” and “acupuncture”, “acup*”, “laser acupuncture”, “electroacupuncture”, “electro-acupuncture.”. No restrictions were applied for the year of publication or study design, and English, German, and Chinese articles were retrieved. From the resulting search, the authors carried out the final review that included peer-reviewed publications.

3. Gender Differences in Manual Acupuncture

MA is the earliest and most widely used method. MA is achieved by manipulating the needles to elicit the de-qi sensation, which is often described as suan (aching or soreness), ma (numbness or tingling), zhang (fullness, distention, or pressure), and zhong (heaviness) [19]. Differences in response to manual acupuncture based on gender have been reported in both Western and Eastern countries. Recently acupuncture and spinal manipulation therapy (SMT) have been used for treating low-back pain (LBP) in a randomized controlled trial conducted in California by Kizhakkeveettil et al. [20]. The outcomes demonstrated gender-specific differences in response to the treatment. Women showed more possibility to reduce pain and disability rates with acupuncture treatment alone, while in men, SMT alone gave better outcomes than acupuncture [20].

Two fascinating articles have been published on the effect of acupuncture on brain function. The goal of one study in the USA reported by Qiu et al. [15] was to compare the sex differences of the brain regions responsible for emotion and cognition in response to acupuncture stimulation. The researchers retrieved the data of 38 subjects (19 male, 19 female) from previous studies, who had brain fMRI during acupuncture and reanalyzed them based on sex status. The result observed significant gender differences at both the networks related to cognition and emotion and the sensation network in the brain, i.e., the limbic-paralimbic-neocortical network (LPNN) and the default mode network (DMN). A few years later, another study performed by researchers from Korea and the Netherlands in 2016 [14] examined gender differences and similarities in the psychophysical and brain responses to acupuncture in 19 healthy participants (9 male, 10 female). During needle manipulation of acupuncture, women reported a higher intensity of aching than men. Moreover, the neural results showed greater brain activation in numerous brain areas in women than men [14]. Gender-specific differences in response to manual acupuncture have the necessary implications for the acupuncture treatment of patients with psychiatric disorders, such as depression [21] and schizophrenia [22]. Gender differences should also be taken into account for depression, especially in TCM diagnosis. A recent study by Bosch et al. [21] concerning depression was published in the German language in 2019. Thirty patients (20 females and 10 males) with depression were recruited from a German psychiatric clinic. The TCM diagnostics showed that females have more emptiness and deficiency, while males show more full patterns with heat.

Gender differences in manual acupuncture have also been reported in the eastern part of the world. In a study performed in Beijing by Dong et al. [23], obese rats were treated by acupuncture. The results indicated that acupuncture works equally on obesity in rats of both gender; however, the effect of acupuncture was better on males than that on females in terms of the body contours of rats. In addition, Fan et al. [24] reported gender differences when treating depression. Patients were treated with acupuncture and moxibustion for 12 weeks (twice a week). About 143 patients completed the study, including 61 males and 82 females. The combined treatment showed
non-statistically significant differences between men and women; however, for the method of shallow puncturing on acupoint, women showed less sensitivity than men. Recently, a study from the point of view of Western and Eastern medicine has been published by researchers from Heilongjiang University of Chinese Medicine, China in collaboration with researchers from the United States [16]. They investigated gender differences and similarities in cerebral activity response to the acupuncture at local acupoints around the knee. The cerebral activity response to acupuncture was measured using fMRI in healthy 15 male and 15 female adults. Acupuncture activated the postcentral gyrus, precuneus, temporal, posterior lobe, and occipital lobe in both males and females. Males showed brain activation in the right middle frontal gyrus, inferior frontal gyrus, right precuneus, right superior parietal lobule, left cerebellum anterior lobe, and brain deactivation in the right frontal. Females showed brain activation in the right frontal lobe, right parietal lobe, and right middle temporal gyrus, and brain deactivation in the left and right medial frontal gyrus. The results of this study demonstrated that the neural effects of local acupoints around the knee are different between male and female subjects [17]. However, they failed to explain the reason for the differences in detail. Besides, the number of participants was not very high to make any firm conclusion.

4. Gender Differences in Electroacupuncture

EA is a form of acupuncture using electrical impulses passing through the needles to stimulate acupoints. Currently, EA is widely used in clinical trials and laboratory research because of its continuity of stimulation and repeatability of operation. Besides, the therapeutic efficacy of EA can be modulated by varying the frequency, intensity, and duration. The evidence of gender differences in response to EA treatment has been mainly reported in China with the first report published in 1986. Du et al. [25] found that the inhibitory effect of EA on the endotoxin-induced thermophilic outcome differs between genders. EA can reduce the body temperature in a female rabbit more than the male, which might be related to the estrogen secretion level. Several studies about gender differences in EA efficacy in the treatment of various diseases have been reported. Li et al. [26] studied the effect of EA on Systolic Time Intervals (STI) which is an index system for evaluating the cardiac function and found that the changes in the differential value of STI indicators are not entirely consistent between male and female. Shi et al. [27] also discussed the effects of the different genders on pain perception and inhibition [28, 29]. A study on the analgesic effect of 100 Hz EA on rats on gender difference indicated that the female rats were stronger than males and this difference was most significant at 20 min of treatment. This difference may be related to the gender difference of morphine analgesia at the spinal cord level. Interpretation of the results, however, has to be done with caution taking into account that these are results from different species. The effect of gender differences in EA on the nervous system is also reflected in the impact of acupuncture on the vagus nerve. By observing the effects of acupuncture at Tongli (HT5) on the heart rate variability of young people (20 female, 20 male), Wang and Shao [30] found that acupuncture at the HT5 can enhance vagal nerve function. Interestingly, the change in females is more significant than that in males. In recent years, gender differences in EA treatment on obesity have become the focus of research. Liu [31] investigated the effect of EA on central obesity and indicated that male patients are more effective than female patients. However, this result is the opposite of another animal experiment conducted by Huang.
et al. [32] which confirmed that the effect of EA on female obesity model rats is better than that of males. This contradiction in results may be related to the acupuncture points selected for the treatment. A research team [33, 34] from Hebei Medical University also concluded that there are gender differences in EA treatment on obesity. They performed further studies on body weight, blood lipids, and other obesity-related indicators and found that the effect of low-frequency EA treatment on reducing body mass index and serum content of adiponectin (ADPN) was more evident in male than female, whereas a decrease in the waist circumference, hip circumference, subcutaneous fat content and serum content of leptin was more pronounced in female than in the males.

From a western perspective, a study conducted by Smeester et al. [35] focused on gender differences in EA treatment for rodent models on persistent pain. They applied EA at the ST–36 acupoint twice weekly for reducing hyperalgesia pain and revealed that the analgesic effect of EA began earlier in males, but lasted longer in females.

5. Gender Differences in Laser Acupuncture

LA is defined as “Photonic stimulation of acupuncture points and areas to initiate therapeutic effects similar to that of needle acupuncture and related therapies together with the benefits of PhotoBioModulation (PBM)” [36]. LA has been used clinically since the 1970s; it is not only a branch of acupuncture therapy but also a form of photobiomodulation therapy that uses (nonthermal) visible and infrared light to promote therapeutic benefits. Painless LA has become a trend in acupuncture, but few studies have focused on gender differences in LA. One report from the research group at the Medical University of Graz in Austria was found in scientific databases. Litscher et al. [18] performed quantitative thermal sensory and pain threshold testing on 29 adult healthy volunteers (20 females, 9 males) before and after laser needle acupuncture and placebo stimulation, respectively [18]. Significant gender-specific differences were observed in cold pain threshold analysis. A changing trend in the median value of cold pain sensation after laser needle stimulation was seen within a group of healthy females [18]. Acupuncture treatment has a curative effect on inhibiting pain; however, quantitative as well as qualitative differences in the endogenous pain inhibitory systems have been implicated, as well as an influence of gonadal hormones. Thus, treatment recommendations should be based on studies using both genders as the norm [17]. In 2018, another study [37] from the same group of the Medical University of Graz reported gender-specific differences in the effects of auricular LA. Within a crossover study, the ear acupuncture point, Shenmen, was stimulated with two different kinds of laser (green, 532 nm, and yellow, 589 nm) in 22 healthy volunteers (13 female, 9 male). Both green and yellow lasers were used in the same volunteers for 15 min in two different sessions. In general, more pronounced effects were found in females than in males. Systolic blood pressure and heart rate decreased significantly after yellow laser stimulation, whereas heart rate variability ratio, i.e., low frequency/high frequency, increased [37]. This is in accordance with an EA study mentioned previously [30].

The mechanisms of LA, however, seem to differ from MA and EA since the light stimulus affects chromophores in the skin, hair follicles, and superficial fat cells [38, 39]. Although gender differences in LA are under-reported, research on photobiomodulation therapy suggests gender differences [40]. In one study, it was reported that sex affects the penetration of red-light (660
nm) through sites susceptible to a sports injury in lean tissues regardless of tissue thickness. Therefore, precise identification of the gender differences in response to LA therapy is crucial to tailor treatment, especially regarding the application of appropriate dose and specific needs in women and men with various diseases.

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Author Contributions

Both authors contributed equally to this editorial.

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Heart Rate Variability during Acupuncture Treatment of Lumbosacral Pain

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Abstract

Pain could be directly related to autonomous imbalance. To date, only one scientific work examining heart rate variability (HRV) and heart rate (HR) as the important parameters of autonomous nervous system (ANS) in the context of clinical routine acupuncture treatments for lumbosacral pain conditions is available in the listed databases. The present study aimed to investigate the short-term effects of HRV and HR, during and after the acupuncture needle stimulation in patients with lower back pain. Eighteen patients (mean age ± SD: 60.2 ± 12.0 years; 15 males and 3 females) were included in the present study. All the investigations were performed at the Privatclinic Lassnitzhoehe, Austria. The trial was conducted and integrated into routine acupuncture therapeutic interventions. Heart rate, as
well as heart rate variability, was measured continuously during needle acupuncture. The main acupuncture points were: Dachangshu (BL25), Zhibian (BL54), Huantiao (GB30), Fengshi (GB31), Yanglingquan (GB34), Xuanzhong (GB39), and Taichong (LV3). The results demonstrated that in comparison to the only existing previous study on the topics of HRV, HR, acupuncture, and lumbosacral pain, similar HR and LF/HF-HRV pattern changes were observed in the present study, while certain slightly different HRV total changes were observed as well. There is evidence that acupuncture may affect the balance of the ANS in patients during lumbosacral acupuncture treatment. Further investigations in this regard are in progress.

**Keywords**

Acupuncture; heart rate variability (HRV); low-back pain (LBP); lumbosacral pain; rehabilitation; heart rate (HR); autonomic nervous system (ANS)

---

### 1. Introduction

Treatment of Lower Back Pain (LBP) using acupuncture mainly involves controlling or reducing pain to return to normal life activities as soon as possible. The most recent international guidelines regarding the topic recommend pharmacological management for pain relief in LBP, which includes paracetamol, non-steroidal anti-inflammatory drugs, muscle relaxants, opioid analgesics, epidural steroids, anticonvulsants, antidepressants, and corticosteroids, among others [1]. However, most of these pharmacological treatments provide limited pain relief and are accompanied by serious side effects, such as drowsiness, dizziness, addiction, allergic responses, reversible reduction in the liver function, and negative impacts on gastrointestinal functions [1]. This raises the requirement for complementary treatments for LBP. Such treatments include multidisciplinary rehabilitation based on physiotherapy, spinal manipulation, exercise therapy, massage therapy, cognitive-behavior therapy, yoga, tai-chi, and acupuncture [1].

The aim of the present study was to investigate the short-term effects of heart rate (HR) and heart rate variability (HRV) during the acupuncture treatment in patients with LBP.

### 2. Methods

#### 2.1. Patients

A total of 18 patients (mean age ± SD: 60.2 ±12.0 years; age range: 38–84 years; mean height ± SD: 167.9 ±7.8 cm; mean weight ± SD: 82.9 ±14.1 kg; mean body mass index (BMI) ± SD: 29.4 ± 4.9 kg/m²; 15 females and 3 males) were enrolled in the study. The enrolled patients did not have any severe neurological or orthopedic disorders. Therefore, no numerical rating scale was used. All the investigations were performed at the Privatclinic Lassnitzhoehe in Austria. The recruitment of the patients for the study was conducted by an experienced neurologist. It was the first acupuncture session for each of the enrolled patients, as none had undergone acupuncture therapy previously. All the patients provided oral informed consent for participation in the study, and the study was
performed in accordance with the principles of the Declaration of Helsinki. Ethical permission for the study was obtained from the institutional review board of the Privatclinic Lassnitzhoehe [2].

2.2 Study Procedures

The study was performed and integrated into routine acupuncture therapeutic interventions. Therefore, there was no control group for the trial. All the patients were subjected to needle acupuncture. The HR and HRV data were analyzed during one single 30-minute-long acupuncture session.

2.3 Acupuncture Points and Needling Technique

The acupuncture points used for LBP treatment in the present study for each patient are listed in Table 1. The description of the acupuncture points is provided in Table 2. The main acupuncture points are depicted in Figure 1.

Table 1 Acupuncture points for LBP used in the present study.

<table>
<thead>
<tr>
<th>Patient number</th>
<th>Side (right R, left L)</th>
<th>Main acupuncture points for LBP *</th>
<th>Additional acupuncture points</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>R</td>
<td>Dachangshu (BL25); Zhibian (BL54); Huantiao (GB30); Fengshi (GB31); Yanglingquan (GB34); Xuanzhong (GB39); Taichong (LV3)</td>
<td>L4 Jiaji point; 1 Ashi point; L5 Jiaji point; 1 Ashi point; Ciliao (BL32); Zusanli (ST36)</td>
</tr>
<tr>
<td>2</td>
<td>L</td>
<td></td>
<td>L4 Jiaji point; L5 Jiaji point; 1 Ashi point; Zusanli (ST36)</td>
</tr>
<tr>
<td>3</td>
<td>L</td>
<td></td>
<td>L4 Jiaji point; L5 Jiaji point; 1 Ashi point; Zusanli (ST36)</td>
</tr>
<tr>
<td>4</td>
<td>L</td>
<td></td>
<td>L4 Jiaji point; L5 Jiaji point; 1 Ashi point; Zusanli (ST36)</td>
</tr>
<tr>
<td>5</td>
<td>R</td>
<td></td>
<td>L4 Jiaji point; 1 Ashi point; Zusanli (ST36)</td>
</tr>
<tr>
<td>6</td>
<td>R</td>
<td></td>
<td>L5 Jiaji point; 1 Ashi point; Zusanli (ST36)</td>
</tr>
<tr>
<td>7</td>
<td>L</td>
<td></td>
<td>L3 Jiaji point; L4 Jiaji point; L5 Jiaji point; 1 Ashi point; Shangliao (BL31); Zusanli (ST36); Zhongji (Ren3)</td>
</tr>
<tr>
<td>8</td>
<td>R</td>
<td></td>
<td>L4 Jiaji point; L5 Jiaji point; 1 Ashi point; Zusanli (ST36)</td>
</tr>
<tr>
<td>9</td>
<td>R</td>
<td></td>
<td>L4 Jiaji point; L5 Jiaji point; Shangliao (BL31); 1 Ashi point; Zusanli (ST36)</td>
</tr>
<tr>
<td>10</td>
<td>L</td>
<td></td>
<td>L4 Jiaji point; L5 Jiaji point; 1 Ashi point; Zusanli (ST36)</td>
</tr>
<tr>
<td>11</td>
<td>L</td>
<td></td>
<td>L3 Jiaji point; L4 Jiaji point; 1 Ashi point; Zusanli (ST36)</td>
</tr>
<tr>
<td>12</td>
<td>R</td>
<td></td>
<td>L4 Jiaji point; L5 Jiaji point; 1 Ashi point; Shangliao (BL31); Ciliao (BL32); Zusanli (ST36)</td>
</tr>
<tr>
<td>13</td>
<td>L</td>
<td></td>
<td>L4 Jiaji point; 2 Ashi point; Weizhong (BL40); Zusanli (ST36)</td>
</tr>
<tr>
<td>14</td>
<td>L</td>
<td></td>
<td>L1 Jiaji point; L4 Jiaji point; L5 Jiaji point; 2 Ashi point; Zusanli (ST36)</td>
</tr>
</tbody>
</table>
*All patients were treated with these main points.*

Table 2 Description of the acupuncture points for LBP used in this study (approx.: approximate; 1 cun = one thumb width) [3].

<table>
<thead>
<tr>
<th>Acupuncture point</th>
<th>Anatomical location</th>
<th>Indication</th>
</tr>
</thead>
</table>
| Dachangshu (BL25) | 1.5 cun lateral to the lower border of the spinous process of L4, approx. level with the upper border of the iliac crest | 1. Abdominal distension, diarrhea, constipation  
2. Lower back and leg pain  
3. Sciatica  
4. Enuresis, nephritis |
| Zhibian (BL54)    | On the buttock, in the depression, 3 cun lateral (about 4 fingerbreadths) to the sacral hiatus. | 1. Lumbosacral pain  
2. Lower limb muscle atrophy, weakness, pain, etc.  
3. Difficult urination  
4. Constipation, hemorrhoids |
| Huantiao (GB30)   | 1/3 the distance from the prominence of the greater trochanter to the sacral hiatus  | 1. Lumbosacral pain  
2. Lower limb muscle atrophy, weakness, pain, etc. |
| Fengshi (GB31)    | On the lateral aspect of the thigh, directly below the greater trochanter, 7 cun above the popliteal crease | 1. Lower limb paralysis  
2. Itching all over the body  
3. Sciatica, lateral femoral dermatitis, etc. |
| Yanglingquan (GB34) | In the depression anterior and inferior to the prominence of the head of the fibula | 1. Jaundice, vomiting  
2. Hypochondriac pain  
3. Paralysis of lower limbs  
4. Knee joint diseases, etc. |
| Xuanzhong (GB39)  | 3 cun superior to the prominence of the lateral malleolus, between the posterior border of the fibula and the tendons of peroneus longus & brevis | 1. Hypochondriac pain  
2. Paralysis of lower limbs,  
3. Dementia, stroke, headache, dizziness, etc. |
| Taichong (LV3)    | On the dorsum of the foot, in the hollow distal to the junction of the first and second | 1. Jaundice, vomiting, hypochondriac pain  
2. Paralysis of lower limbs, swelling and sore feet |
<table>
<thead>
<tr>
<th>Point</th>
<th>Location</th>
<th>Disorders</th>
</tr>
</thead>
<tbody>
<tr>
<td>metatarsal</td>
<td></td>
<td>3. Dementia, stroke, headache, dizziness</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. Irregular menstruation, dysmenorrhea, etc.</td>
</tr>
<tr>
<td>L1 Jiaji point</td>
<td>0.5 cun lateral to the lower border of the spinous process of L1 approx.</td>
<td>Lower back pain, lower limb pain</td>
</tr>
<tr>
<td>L3 Jiaji point</td>
<td>0.5 cun lateral to the lower border of the spinous process of L3 approx.</td>
<td></td>
</tr>
<tr>
<td>L4 Jiaji point</td>
<td>0.5 cun lateral to the lower border of the spinous process of L4 approx. level with the upper border of the iliac crest</td>
<td></td>
</tr>
<tr>
<td>L5 Jiaji point</td>
<td>0.5 cun lateral to the lower border of the spinous process of L5 approx.</td>
<td></td>
</tr>
<tr>
<td>Ciliao (BL32)</td>
<td>In the second sacral foramen</td>
<td>1. Nocturnal emission, orchitis</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Irregular menstruation, dysmenorrhea,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Difficult urination, hernia</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. Lumbosacral pain, lower limb muscle atrophy, weakness, pain, etc.</td>
</tr>
<tr>
<td>Shangliao</td>
<td>In the first sacral foramen</td>
<td>1. Irregular menstruation and other gynecological diseases</td>
</tr>
<tr>
<td>(BL31)</td>
<td></td>
<td>2. Nocturnal emission, constipation, difficult urination,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Lumbosacral pain</td>
</tr>
<tr>
<td>Zusanli (ST36)</td>
<td>3 cun inferior to the hollow formed by patella &amp; patella ligament. A fingers breadth lateral to the anterior crest of the tibia at a level just inferior to the lower border of the tibial tuberosity</td>
<td>1. Stomach ache, vomiting, bloating, dysentery constipation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Lower limb paralysis</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Palpitations, insomnia, fatigue, etc.</td>
</tr>
<tr>
<td>Zhongji (Ren3)</td>
<td>On the anterior midline, 3 cun below the umbilicus (2 cun superior to the pubic symphysis)</td>
<td>Dysmenorrhea, irregular menstruation, pelvic inflammation, cystitis, sexual dysfunction, prostatitis, urinary retention</td>
</tr>
<tr>
<td>Weizhong (BL40)</td>
<td>On the posterior aspect of the knee, on the crease and in a depression midway between the tendons of biceps femoris and semitendinosus</td>
<td>1. Lower back pain, lower limb paralysis and other lower limb disorders</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Abdominal pain, enuresis, difficulty urination</td>
</tr>
<tr>
<td>1 Ashi point</td>
<td>Local tenderness point</td>
<td>Treats and relieves pain</td>
</tr>
</tbody>
</table>
Needling was performed in accordance with the Chinese standard procedures (with respect to depth and direction), using single-use needles (0.30 × 30 mm and/or 0.30 × 40 mm; Huan Qiu, Suzhou, China). Needle stimulation was performed clockwise as well as counter-clockwise, each for 15 s, with two rotations per second, resulting in 30 rotations per stimulation. Stimulation was performed immediately after inserting the needle, 10 min later, and immediately before removing the needles (Figure 2).

**Figure 1** Main acupuncture points for low back pain (LBP).

**Figure 2** Measurement procedure (before acupuncture (a); during acupuncture (b–e); after acupuncture (f)).
2.4 Evaluation Parameters

HR and HRV, which have been used successfully in numerous acupuncture studies conducted previously, were the primary target parameters for the present study [4]. The parameters were measured in a quiet room after a resting period of at least 5 min. The HRV analysis was performed using Medilog® AR12 HRV system (Huntleigh Healthcare, Cardiff, UK) from the TCM research center of the Medical University in Graz. Registration was performed using three adhesive electrodes (Skintact Premier F–55; Leonhard Lang GmbH, Innsbruck, Austria) applied to the chest of each patient. Six measuring phases (a–f; Figure 2), each being 5-min long, were compared, one prior to stimulation (a), four during the acupuncture treatment (b–e), and one after the acupuncture treatment (f).

HR and HRV were measured continuously during the acupuncture treatment. The sampling rate of the HRV system was 4,096 Hz. The raw electrocardiographic data were stored on a memory card, and were subsequently read out using a card reader connected to a standard computer. HRV was presented in such a manner that the function of the autonomic nervous system was assessable [4]. Low frequency/high frequency (LF/HF) and the mean value of the heart rate (HR), recommended by the Task Force of the European Society of Cardiology and the North American Society for Stimulation and Electrophysiology, were quantified as the electrocardiographic variables [5].

2.5 Statistical Analysis

Data analysis was performed using SigmaPlot 14.0 software (Systat Software Inc., Chicago, IL). Graphic presentation of the results was achieved using box plot illustrations. Testing was performed using a one-way repeated measures analysis of variance, Kruskal-Wallis one-way analysis of variance on ranks, and Tukey’s test. The significance threshold was set at P < 0.05.

3. Results

The mean HR prior to, during, and after the acupuncture treatment of the 18 patients are presented in Figure 3. No significant alterations were observed either among the different conditions (a–f) or prior to and after the acupuncture treatment (P = 0.975). HR did not appear to change significantly during the first phase (b) after the insertion of needles.
**Figure 3** Mean heart rate (HR). Box plot illustration for the 18 patients with lower-back pain prior to (a), during (b–e), and after (f) the needle acupuncture treatment. No significant changes were observed. The dotted horizontal lines in the boxes depict the position of the median. The end of the box defines the 25<sup>th</sup> and 75<sup>th</sup> percentiles, and the error bars mark the 10<sup>th</sup> and 90<sup>th</sup> percentiles (n.s.: not significant).

The results for the analysis of total HRV are depicted in Figure 4. A significant decrease in total HRV was observed during and immediately after the acupuncture treatment.

**Figure 4** Total heart rate variability (HRV). Box plot illustration for 18 patients with low-back pain before (a), during (b–e), and after (f) needle acupuncture. The graphic shows significant changes during the phases c–f (a.u. = arbitrary unit). Further explanations are given in Figure 3.
Furthermore, during and after the acupuncture treatment, significant reductions in the LF/HF ratio of the HRV were observed (Figure 5).

**Figure 5** LF (low frequency)/HF (high frequency) ratio. Box plot illustration for the 18 patients with low-back pain before (a), during (b–e), and after (f) needle acupuncture. Further explanations are given in again Figure 3.

4. Discussion

HRV is an index representing the function of the autonomic nervous system (ANS), and serves as a reliable method for obtaining information regarding the sympathetic and parasympathetic nervous systems. Recent studies have demonstrated that changes in sympathovagal balance could be related to acupuncture treatment [4].

The present exploratory study was aimed to evaluate the effect of acupuncture treatment on the ANS reactivity in patients with lumbosacral pain. The results revealed that compared to the only existing study on the topic of HRV, acupuncture, and lumbosacral pain [2], similar HR and LF/HF-HRV pattern changes were observed in the present study as well, while certain slightly different HRVtotal changes were also observed.

There is evidence that acupuncture is capable of affecting the balance of the ANS. Generally, acupuncture is able to improve either vagal or sympathetic tone, depending on which acupuncture points have been stimulated [4]. In the present study, the LF/HF value during and after the acupuncture treatment increased significantly compared to the initial values before the treatment. A possible reason for the statistical significance of the results of the present study, as well as the previous study [2], could be that acupuncture, as a kind of external stimulation, stimulates the human body to elicit its reflex defense reaction. However, a stress response caused by adequate needling may gradually disappear and turn into positive stimulation.

Acupuncture has been used frequently in the past for the treatment of lower back pain [1]. The underlying mechanism could be related to the activation of endogenous opioids and neuropeptides through the stimulation of specific structures in the brain. It has been reported that
acupuncture could be applied as a supplementary procedure to reduce pain and thereby improve the quality of life in patients [1].

The ANS comprises two components: the sympathetic nervous system, which is responsible for the flight and stress reactions, and the parasympathetic nervous system, which dominates when a person relaxes. The low-frequency band LF (0.04–0.15 Hz) in HRV mainly reflects the sympathetic activity, while the high-frequency component HF (0.15–0.4 Hz) is regarded as an index of parasympathetic nerve activity. The LF/HF ratio, therefore, reflects the sympathovagal balance [1, 2, 4–6].

The patients suffering from pain could have impaired ANS function. A previous study conducted by our research group demonstrated that the LF/HF ratio was significantly increased in patients after treatment of the lumbosacral pain [2]. Although the present study did not exactly demonstrate this type of outcome, there nonetheless exists a parallel to this previous study. The results clarified that the LF/HF ratio, and not the mean HR, could be modulated through the acupuncture treatment using different acupuncture points. ANS modulation is closely related to the ANS tone (medium HR), and is, therefore, associated with an increase in the sympathetic activity and a decrease in the vagal tone, and consequently with an increase in HR and a decrease in its variability [6]. This implies that a physiological correlation exists between HRV and HR. However, in a simulation study, it was demonstrated that the changes in the ANS modulation should be independent of the changes in the mean HR [7]. This is consistent with the findings of the present study. Acupuncture is able to modulate the ANS through the activation of the sympathetic and parasympathetic nervous systems.

The present study also has certain limitations. Firstly, the sample size was relatively small, which limits the significance of the possible different effects of using different acupuncture methods (points). Since there is only one similar study reported previously [2], it was not possible to calculate the sample size on the basis of differences in the HRV modulated using needle acupuncture treatment. Secondly, registration of a control group was not possible in this preliminary trial because, as stated in the introduction section, the tests were integrated into the routine acupuncture therapeutic interventions in a rehabilitation clinic. Thirdly, it would be interesting for future studies to evaluate how the duration of the acupuncture treatment (at least 6 to 10 sessions) would affect the clinical outcomes. It is possible that more prolonged acupuncture treatment would be more beneficial for pain relief. Finally, although the acupuncture points commonly used to treat LBP are Yaoyu (GV2), Huantiao (GB30), Yanglingquan (GB34), Shenshu (BL23), Dachangshu (BL25), Yaoyangguan (GV3), and Weizhong (BL40) [8, 9], a slightly modified acupuncture scheme was used in the present study. Since no control group was used, it appeared at first that it was unclear whether the changes being observed were a result of the acupuncture treatment, the act of lying down for 30 min, or the psychological factors such as hoping to achieve pain relief from the treatment or all of the above. However, in relation to previous works [2, 4], the possibility of the measured effects arising only from lying down or from psychological factors could be excluded.

In 2010, Lee et al. [10] summarized the important references in the literature and stated that sham-controlled randomized controlled studies presented variable results and no clear evidence that acupuncture exerted any specific effects on HRV. Therefore, more rigorous research is warranted. Meanwhile, extensive basic research has been conducted regarding this topic, which
clearly demonstrates that acupuncture and, for example, moxibustion could exert effects on HR and HRV, respectively [6, 11].

The results of the present study, which represent a low vagal tone, could be associated with qi deficiency based on the TCM theory, according to a previous study [12]. Moreover, qi deficiency is one of the significant diagnoses made by the traditional Chinese medical acupuncturists for patients with lower back pain [13]. Therefore, the change in the HRV of patients observed in the present study possibly reflects that acupuncture has a therapeutic effect on the patients with lower back pain through the regulation of the balance of qi.

Future research could include other assessment variables and the investigation of the long-term HRV effects of different acupuncture schemes on patients with lumbosacral pain.

5. Conclusion

The present study revealed that HR did not change significantly, while there were significant changes in HRV_total and the LF/HF ratio of HRV during a single acupuncture session in the patients with LBP. There was a significant alteration in HRV between the time points of the beginning and the completion of the acupuncture treatment. Current studies related to this topic are limited in number and have been conducted in very small groups, rendering it difficult to draw reliable conclusions. Therefore, future studies using the same standardized acupuncture scheme in all patients and involving a greater number of acupuncture sessions shall assist in elucidating certain open questions in this field of study.

Acknowledgments

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Author Contributions

All authors (Y.Y., G.L., Z.S., and L.W.) designed the study. Z.S. and Y.Y. performed the acupuncture and the HRV measurements in the clinic. Y.Y. and G.L. analysed the data. G.L. wrote the paper with input from all authors (Y.Y., Z.S., L.W.).

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Competing Interests

The authors have declared that no competing interests exist.
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The treatment by auricular therapy has a long history. Ear acupoint research has been advancing step by step worldwide [1-17]. The introduction of lasers into medicine brought besides the already existing stimulation with needles, electricity, pressure and liquids an additional technique to auricular acupuncture.

The RAC (Reflex Auriculo-Cardiac) represents an important scientific method in the field of auricular medicine. At the TCM Research Center of the Medical University of Graz, new methodological strategies for recording and objectifying the dynamic pulse changes were scientifically investigated and described. With high-resolution imaging of pulsatile surface changes, the RAC can be reproducibly quantified for the first time. One of the methods consists of a combination of an innovative microscope system of the Medical University of Graz, a video software analysis and special image processing programs of the Beijing University of Science and Technology. First test measurements document the realization of the new method approach (Figure 1 and 2).
Quantification of the RAC (modified from [7]).

Figure 1

Proof of the dynamic changes in the laboratory using alterations at the surface (modified from [7]).

Figure 2

Sino-European transcontinental basic and clinical high-tech auricular acupuncture studies demonstrate the modernization of auricular acupuncture and the scientific way from auricular therapy to auricular medicine (Figure 3).

Figure 3

Modernization of auricular acupuncture and the scientific way from auricular therapy to auricular medicine.

Auricular medicine has come of age and has gained the attention of the wider medical
community in recent years.

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**References**


New Paradigm in International Ear Acupuncture

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Special Issue: Modernization of Acupuncture Education and Research

Abstract:

Background: In the international auriculotherapy practice there are relatively big differences in the exact localization of the same ear acupuncture point. On one hand, there are specialists who devote their efforts to find the active points. In that case it becomes intriguing that there may be another point (at 1-2 mm distance) near the point to be treated, indicating a relatively strong, even stronger activity than the one they were initially aiming to find. That point may be active because of another health problem. On the other hand, it may also occur that the same acupuncture point is localized 10-20 mm away from its correct place. Owing to the inaccurate localization, the treatment will not have the expected effect to the ear acupuncture point indications and will cause disappointment to the patient and frustration to the therapist.

The ‘Széchenyi Orientation Ear Map’ offers a solution to the internationally debated problem of the adequate localization and standardization of ear acupuncture points.

The ear map offers a solution for finding the exact location of acupuncture points in one uniform/flexible arrangement in various ear acupuncture systems, from the Chinese or Nogier’s ear acupuncture points to Széchenyi’s 191 ear acupuncture points. It is important to emphasize that apart from the correct diagnosis, the basis of successful therapy is finding the adequate localization of the acupuncture points.
**Methods:** We localize the acupuncture points on a comparative basis, that is to say, we use relative localization. To attain this, we put to use the anatomical formulas of the ear. Furthermore, the orientation points, the main orientation lines and the auxiliary orientation lines help determine the exact localization.

**Results:** The exact place of the acupuncture point determined with the aid of the orientation map and the relative localization spot will always be at the same place. Using this method one soon discovers that every ear has basically the same shape.

Thus, it can be avoided that within the same or in different countries minimum 2 points from among the National Acupuncture Detoxification Association (NADA) or Battlefield (BLF) 5 ear points get to an unlikely position or 15–20 mm further away on the top of the ear. It is important not to mix the positions as it is not the same if the needles are inserted in the Allergy point instead of the Omega 2 point, or Zero point will take the place of the Liver point.

**Conclusions:** The orientation points, the main- and auxiliary orientation lines will unambiguously help the therapist to accurately localize the acupuncture points, no matter the shape of the ear. Furthermore, they also enable to better comprehend the location of those points on different maps.

Therapists will not come to a dead-end by trying to find the active points, and meanwhile end up treating a point responsible for another health problem instead of treating what they aim for. Consequently, it is important to be able to identify the proper location of the active points in question.

**Keywords**

Ear acupuncture; localization; auricular medicine, NADA, battlefield, auriculotherapy, ear map

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1. Introduction

At the onset, traditional medicine had preference for using ear acupuncture. This predilection can be traced back in numerous works of art e.g. Hieronymus Bosch’s painting in the Prado museum “The Garden of Earthly Delights”. [1]

At the beginning of the 1900s, Madam Barrin, a medicine-woman in the outskirts of Lyon, had good results cauterising certain areas of the ear. Paul Nogier, a French neurologist, was enthused by her results and initiated the scientific examination of ear acupuncture. His first publications were issued in Germany in 1956. Motivated by the success of the French doctor, publications of Chinese specialists came out to reveal that they also have their own system of ear-acupuncture [2].

With regard to the mechanism of different effects, it is important to make a difference between the two approaches: Nogier’s method is a reflex therapy, while the Chinese medicine re-establishes the energy balance. We can distinguish the two different effects; however, they cannot be separated because in practical experience they appear simultaneously.
Several ear-maps were issued all around the world, but specialists encountered an even greater problem— the adequate localization of ear acupuncture points, e.g. Dr Széchenyi’s 191 points [3], Dr Bahr’s Ear Acupuncture Chart (17) and Dr. Romoli’s auricular sectogram [4].

Attempts were made for the sake of standardization, such as Dr. Romoli’s radial map, Alimi effort to create an international nomenclature [5], as well as Bahr’s reticulated map. All of these attempts emphasized that the exact localization is an invariable difficulty because every ear is different and all of them are dissimilar.

![Figure 1 Dr. Romoli’s map [4].](image)

![Figure 2 Dr. Bahr’s map (17).](image)
1.1 The "Széchenyi Orientation Ear Map"

The "Széchenyi Orientation Ear Map" [6] offers a solution to the international problem of correct localization and standardization of ear acupuncture points. It is the result of my 25 years of teaching, clinical and research experience. The ear map offers a solution for finding the diverse ear acupuncture systems in one uniform/flexible arrangement, whether it is the Chinese [7] or Nogier’s ear acupuncture points [8], or Széchenyi’s 191 ear acupuncture points in their exact localization [3]; the basis of successful therapy is to find the accurate localisation apart from the correct diagnosis. Thus, the place of the internationally known 5 standard points of both NADA [9] and Battlefield [10] systems can easily be found.

In 1985, Michael Smith, MD, (Lincoln Hospital, Bronx, NY) developed the National Acupuncture Detoxification Association (NADA protocol). This protocol was used to alleviate withdrawal symptoms and to stop drug cravings. The standard NADA protocol points are: Shen Men, Sympathetic, Kidney, Liver, and Lung. (18)

The Battlefield ear acupuncture protocol was developed by R. Niemtzow to be used as a fast pain reliever. ASP semi-permanent needles are used to stimulate the following points in the ear: Cingulate Gyrus, Thalamus Point, Omega 2, Point Zero and Shen Men [10].

By following the Széchenyi Orientation Ear Map, one will not insert the needles 1 to 2, or even 10 to 15mm farther than their exact position. This way inefficient treatments and patients’ disappointment may be avoided. Looking for active acupuncture points is a very good method, as a few mm apart from the points to be treated are other projection areas, which may have a signalling value in indicating other disorders. Even some additional problems might be settled, apart from the one the therapist would like to treat. The acupuncture point is an objective formula. This statement was sustained by Kellner, the Viennese histologist who examined acupuncture points in 11,137 histological samples and found that they are objective formations. With his biopsy he revealed that in little circles around the points, which are a few mm in diameter, the number of different nerve filaments (Meissner corpuscles, Krause bulboid corpuscles, Glomus Organs, smooth muscle cells) is significantly bigger than in the areas surrounding those circles [11].

Measuring and monitoring skin resistance of acupuncture points dates back to the 50’s, to the independent work of Nakatani (1950), Niboyet (1958), and Voll (1975). Nakatani (1956) developed the Ryodoraku theory [12].

The emergence of "Széchenyi Orientation Ear Map" as a new paradigm in the international ear-acupuncture was introduced at the 9th International Auriculotherapy Symposium in Singapore in August 2017. We published our research on the topic, in June 2018, entitled: “A comparative study on stress-level reducing effect of Auriculotherapy executed by soft laser and acupuncture methods (NADA/Battlefield) – as it is reflected in Western and Oriental medicine. A randomised, placebo-controlled, double-blind trial” [13].

In our research it is clearly demonstrated the importance of exact localization. The acupuncture points, where the needles are inserted, really makes a difference. In the case of inaccurate localization and insertion, we will not reach the expected therapeutic effect. When examining the PRL and CORT response levels of the human body, NADA 5-point treatment (either needle or laser treatment) shows an immediate significant stress-reducing effect while none was observed in the Battlefield treatment [13].
2. Materials and Methods

In order to compare different ear maps, we used public electronic databases (e.g. PUBMED) and websites related to NADA and Battlefield protocols. Furthermore, we have been assisting with materials related to ear maps published in book form.

The solution is very simple: localization of the ear points is based on comparison, that is, we apply the so-called relative localization. To achieve this, we use the anatomical formulas of the ear, as well as the Orientation Points, Main Orientation Lines and Auxiliary Orientation Lines further help find the exact localization.

Every ear has a Peak Point, the Earlobe – the Lobolus has a center, Fossa Triangularis and Concha has also a center, these are called 'Fixed Orientation Points' and marked with a red circle. Furthermore, the Fossa Triangularis can be divided into approximately 2 equal parts with a symmetry axis. The Antitragus can be virtually completed into an ellipse and the Tragus can be converted into rhombus or rectangle: these are the 'Main Orientation Lines'. Then, the lines of Fossa Triangularis can be further subdivided with the 'Auxiliary Orientation Lines' (figure 3)

Since a non-fixed coordination system is used to define the ear acupuncture points, the flexibility of the "Orientation Ear Map" provides the precision regardless of the outlook of the patient’s ear.

![Figure 3 The Széchenyi Orientation ear map [6].](image)

3-4. Results/Discussion

Thanks to the "Orientation Ear Map" and the relative localization, the location of the acupuncture points will always be the same. Using this method, one soon discovers that every ear is basically the same. As Michelangelo said, "Every block of stone has a statue inside it and it is the sculptor’s task to discover it". By applying the "Széchenyi Orientation Ear Map" we do not fall into...
the trap of or make the mistake of trying to fit the same garment onto a 180 kg person, one of 90 kgs or a person of 65 kgs - meaning that we use the same standard template for ears that are considered different.

As for example, it may not occur that within the same or in different countries at least 2 points from among the NADA 5 ear points are dissenting (figure 4-6), or the needles are inserted in the Zero point at a 10-15 mm distance in Battlefield acupuncture (figure 9 and 10).

![Figure 4 NADA 5 point in Cape Town [14].](image)

![Figure 5 NADA 5 point in Austin (USA) [15].](image)
Figure 6 NADA 5 point in Portland (USA) [16].

Figure 7 NADA 5 points on Orientation Ear Map [6].
Figure 8 NADA 5 points [18].

Figure 9 Battlefield points [10].
Figure 10 Battlefield points [10].

Figure 11 Battlefiled points on the Orientation Ear Map [6].
We might even mention the study “New Universal Nomenclature in Auriculotherapy”, in which applying the orientation points and lines, the Omega2 point should not appear on the tip of the ear, as this is consistently the Allergy point according to both Nogier, and the Széchenyi 191-point map. So, the matter is not a 1-2 mm drift, but a 15-20 mm inaccuracy.

5. Conclusions

Utilizing the Széchenyi Orientation Ear Map, it does not matter what specification the map has, the Orientation Points, the Main- and Auxiliary Orientation Lines unanimously help the therapist to accurately localize the acupuncture points, no matter the shape of the ear. It also enables to better comprehend the ear-acupuncture points of other different maps. Therapists will not come to a dead-end by trying to find the adequate location of active points, they will prick the needle into a spot that is responsible for another disorder. On the contrary, they will be able to identify the proper location of the active points.

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Author Contributions

The author gives final approval of the version to be submitted and any revised version.

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Competing Interests

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Modulation of Excitability of Spinal Neural Functions by Acupoint Stimulation Physical Therapy at LU5 (Chize) in Three Hemiplegic Patients with Cerebrovascular Disease

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Abstract

(1) **Background**: Acupoint stimulation physical therapy (ASPT) is a novel technique that combines physical and acupuncture methods. In this study, we examined the effects of ASPT in three hemiplegic patients with cerebrovascular disease using F-wave as a measure of the excitability of spinal neural function.

(2) **Methods**: Subjects comprised three hemiplegic patients with cerebrovascular disease who presented with three types of neurological findings. All patients had moderate muscle hypertonia on the affected side. Tendon hyperreflexia was graded as slight, moderate, or severe. We applied inhibitory ASPT at LU5 (Chize) for hypertonia of the thenar muscles on the affected side. The F-wave was measured before, during, and after ASPT and was analyzed in terms of persistence, amplitude ratio of F/M, and latency.

(3) **Results**: The amplitude ratio of F/M gradually decreased during and after ASPT compared with that before ASPT. No significant differences in persistence and latency were found before, during, and after ASPT.
(4) **Conclusions**: The inhibitory ASPT method is implicated as a therapeutic approach that decreases muscle tonus in patients with cerebrovascular disease.

**Keywords**
Acupoint stimulation physical therapy; F-wave; LU5 (Chize); cerebrovascular disease

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**Introduction**

In cases of cervical dystonia, it is important to identify the affected muscles through clinical evaluation and electromyography findings derived from motion analysis. For the treatment of muscle tonus abnormalities, pre-sterilized disposable acupuncture needles (diameter, 0.2 mm; length, 50 mm) are inserted ipsilaterally into three acupoints selected on the basis of the meridian concept of typical distal acupoints along lines running through the affected muscles (Figure 1). These acupoints are LI4 (Hegu; on the dorsum of the hand, radial to the midpoint of the second metacarpal bone) for the affected sternocleidomastoid muscle, TE5 (Waiguan; on the posterior aspect of the forearm, at the midpoint of the interosseous space between the radius and the ulna, 2 B-cun proximal to the dorsal wrist crease) for the trapezius, and SI3 (Houxi; on the dorsum of the hand, in the depression proximal to the ulnar side of the fifth metacarpophalangeal joint, at the border between the red and white flesh) for the splenius muscle (SPL).

![Figure 1 Relationship between affected muscles and acupoints.](image)

Acupoints were LI4 for the affected sternocleidomastoid muscle (SCM), TE5 for the affected trapezius and SI3 for the affected splenius muscle (SPL).

Based on this, we developed the acupoint stimulation physical therapy (ASPT) technique as a novel concept in physical therapy (Figure 2) [1-4].
The characteristics of ASPT are as follows: acupoints are pressed on the basis of the meridian concept of typical distal acupoints along the lines running through the affected muscles. Acupressure is applied at the maximum magnitude without pain and for the duration required to change the muscle tonus. Acupressure is applied vertically to decrease muscle tonus and obliquely to increase muscle tonus.

We previously reported the clinical effects of ASPT on flexion contracture of the knee joint in a patient with chronic hemiplegia secondary to cardiovascular disease [5]. The effects were investigated in terms of alterations in the range of motion (ROM) in the patient presenting with contracture in both knee joints and shortening of the hamstring muscles. We applied ASPT to either BL60 (Kunlun; on the posterolateral aspect of the ankle, in the depression between the prominence of the lateral malleolus and the calcaneal tendon) or KI3 (Taixi; on the posteromedial aspect of the ankle, in the depression between the prominence of the medial malleolus and the calcaneal tendon) to decrease the muscle tonus of the hamstring. We then monitored the effect by measuring ROM of the knee extension before and after applying ASPT. ASPT at BL60 (Kunlun) and KI3 (Taixi) caused decreased muscle tonus leading to significantly improved ROM of the knee extension.

In this study, we examined the effects of ASPT in hemiplegic patients with cerebrovascular disease using F-wave as a measure of excitability of spinal neural function.

Ethics Statement

This study was approved by the Research Ethics Committee at Kansai University of Health Sciences (Japan). The experiments were conducted in accordance with the Declaration of Helsinki.

Materials and Methods

Subjects comprised three hemiplegic patients with cerebrovascular disease and three types of neurological findings. All patients had difficulty in moving the thumb due to moderate hypertonia of the thenar muscles on the affected side; however, the grade of tendon hyperreflexia ranged from slight (Case 1), to moderate (Case 2) to severe (Case 3) judged according to the range and speed of tendon reflex.

Subjects were positioned comfortably in the supine position with sufficient freedom of movement to apply external rotation of both shoulder joints. Abrasive gel was applied to the skin to maintain an impedance of <5 kΩ. After stimulating the median nerve of the wrist at rest, the
F-waves of the affected thenar muscles were recorded using the VIASYS Viking Quest electromyography system (Natus Medical Inc. CA, USA) via a pair of circular electrodes attached (with Collodion) to the skin over the abdomen and the bone of the metacarpophalangeal joint of the thumb. The stimulating electrodes comprised a cathode and an anode placed over the affected median nerve at 3 cm and 5 cm, respectively, proximal to the palmar crease of the wrist joint. The maximal stimulus was determined by delivering 0.2-ms square-wave pulses of increasing intensity to elicit the largest compound muscle action potentials. Supramaximal shocks (adjusted up to a value >20% higher than the maximal stimulus) were delivered at 0.5 Hz for the acquisition of F-waves. The bandwidth filter ranged from 2 to 3 kHz.

Next, we recorded the F-waves at 0 min (post 0), 5 min (post 5), 10 min (post 10), and 15 min (post 15) after the application of ASPT for 1 min at LU5 (Chize; on the anterolateral aspect of arm, just lateral to the border of the biceps brachii muscles, 3 B-cun inferior to the anterior axillary fold) on the affected side, with maximal vertical pressure without pain (Figure 3).

![Figure 3](image)

Figure 3 Inhibitory ASPT method used in this study.

The F-waves measured in 30 trials were analyzed with respect to persistence, amplitude ratio of F/M, and latency. Persistence was defined by the number of measurable F-wave responses divided by 30 trials of supramaximal stimulation. The amplitude ratio of F/M was defined as the mean amplitude of all responses divided by the amplitude of the M-wave. Latency was defined as the mean latency from the time of stimulation to the onset of a measurable F-wave.

**Results**

The amplitude ratio of F/M decreased gradually during and after ASPT compared with that before ASPT (Figures 4–6). No significant differences in persistence and latency were found before, during, and after ASPT. Typical F-wave electromyographs for each case are shown in Figures 7–9.
Note: The amplitude ratio of F/M decreased gradually during and after ASPT compared with that before ASPT.

**Figure 4** Amplitude ratio of F/M by ASPT at LU5 (Chize) in a patient with cerebrovascular disease (CVD) (Case 1).

Note: The amplitude ratio of F/M decreased gradually during and after ASPT compared with that before ASPT.

**Figure 5** Amplitude ratio of F/M by ASPT at LU5 (Chize) in a patient with CVD (Case 2).
Note: The amplitude ratio of F/M decreased gradually during and after ASPT compared with that before ASPT.

**Figure 6** Amplitude ratio of F/M by ASPT at LU5 (Chize) in a patient with CVD (Case 3).

**Figure 7** Typical F-wave at rest, during, and after ASPT (Case 1).
Figure 8 Typical F-wave at rest, during, and after ASPT (Case 2).

Figure 9 Typical F-wave at rest, during, and after ASPT (Case 3).
Discussion

In this preliminary study, patients had moderate hypertonia with different types of neurological findings and tendon hyperreflexia on the affected side, which was influenced by the excitability of the central neuron function and varied in each case. Case 3 showed severe hyperreflexia, while Case 2 was moderate, and Case 1 was mild with hyperexcitability of the central neuron function.

The F-wave is a result of backfiring of α-motoneurons following an antidromic invasion of propagated impulses across the axon hillock [6]. Its occurrence reflects changes in the excitability of spinal motor neurons, as reported in patients with spasticity [7,8]. We investigated spinal neural functions by evaluating the F-wave in patients with cerebrovascular disease [8]. The persistence and amplitude ratio of F/M in patients with cerebrovascular disease were affected by the grade of muscle tonus, tendon reflex, or voluntary movement. Eisen and Odusote demonstrated that persistence depends on the number of neuromuscular units activated, and the amplitude ratio of F/M depends on their excitability [9]. In their study, neurological tests for muscle tonus, tendon reflex, and voluntary movement revealed that the F-wave was influenced by the treatment.

In this study, we investigated the effects of the inhibitory ASPT method in patients with hypertonia and hyperreflexia caused by cerebrovascular diseases by observing F-waves as indicators of a change (in this case, a decrease) in muscle tonus. The resulting amplitude ratio of F/M following the application of ASPT at LU5 (Chize) on the affected side showed decreased excitability of spinal neural functions for the thenar muscle with several types of hyperreflexia.

These results can be explained by a combination of neurophysiology and Traditional Oriental medicine concepts. The LU5 (Chize) region is controlled by the C6 area at the dermatone level, and the thenar muscles are also controlled by the same C6 area. Vertical stimulation of the C6 area at the dermatone level inhibited the function of the primary sensory area, primary motor area, and spinal neural functions of the C6 area.

In Traditional Oriental medicine, vertical stimulation of acupoints inhibits the function of the meridian and the energy of related muscles. In our study, vertical stimulation of LU5 (Chize) inhibited the functions of the meridian and tonus of the related thenar muscles.

Thus, we suggest that the inhibitory ASPT method effectively decreases muscle tonus in patients with cerebrovascular disease. In Cases 1 and 3, the amplitude ratio of F/M was recovered at 15 min following ASPT at LU5 (Chize). It is difficult that Inhibition ASPT on LU5 (Chize) may continue inhibitory effect for a long time.

Conclusion

The application of inhibitory ASPT at LU5 (Chize) is implicated as a therapeutic approach that decreases muscle tonus in patients with moderate muscle hypertonia of the thenar muscle on the affected side that is secondary to cerebrovascular disease.

Author Contributions

Dr. Suzuki and Dr. Tani were established ASPT and tested the F-wave by ASPT for neurological disorders. Mr. Takamori and Ms. Yamada were especially tested the F-wave by ASPT for hemiplegic patients with cerebrovascular disease. Data of this research was mainly analyzed by Dr. Tani.
Competing Interests

The authors have declared that no competing interests exist.

References

Case Report

Increase in Electrodermal Activity on Acupuncture Points of Lymphatic, Lung, Nervous, Endocrine and Heart Meridians after Running Exercise, a Single Case Study

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Abstract

Background: Electrodermal measurement of acupuncture points has been correlated to physiologic and pathologic conditions with clinical and laboratory studies. Emerging evidence indicates that in addition to therapeutic effect, acupuncture points may also have diagnostic properties. However, physiologic basis of this phenomenon is still unknown.

Objective: To determine how electrodermal activity of acupuncture points on hands and feet responds to exercise-induced sympathetic stress and how electrodermal measurement correlates to skin temperature.

Materials and Methods: A 20-minute running exercise with a moderate intensity based on Borg Rating of Perceived Exertion Scale was carried out with one healthy male subject for 15 sessions. Electrodermal activity of acupuncture points was tested before and after exercise with a meridian testing system, Electroacupuncture According to Voll. Bio signs including heart rate, breathing rate, blood oxygen level and skin temperature for forehead, hands and feet were also measured.
**Result:** Significant increase in electrodermal activity for five hand meridians, including Lymphatic, Lung, Nervous system, Endocrine systems and Heart, was observed after exercise. There was no significant change for the rest of hand meridians and foot meridians. Significant increase in foot skin temperature and decrease in hand and forehead temperature were also observed after exercise. The change in skin temperature for hand and foot was inversely related to that of electrodermal measures.

**Conclusion:** Despite the limitations, the finding of the study is consistent with expected physiologic responses to the stress due to running exercise and it is feasible to conduct clinical studies with larger sample size to further study the change of electrodermal activity of acupuncture points after exercise. It also suggests that electrodermal testing of acupuncture points may be useful to detect stresses from corresponding organs and tissues. More clinical and mechanistic studies are warranted.

**Keywords**
Electroacupuncture according to Voll; acupuncture point; meridian; electrodermal activity; sympathetic skin response; vasomotor response

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1. **Introduction**

Electrodermal measurement of acupuncture point (AP) and its correlations to physiologic conditions have been studied since the 1950’s. Early independent studies suggested that skin of acupuncture points showed unique electrical characteristics. [1-4] Recent studies have suggested that 1) acupuncture points show lower electrical skin resistance and higher conductivity than surrounding tissue; 2) change in electrical resistance of specific acupuncture points is correlated to certain clinical conditions; 3) clinical and laboratory studies show that experimentally induced physiological dysfunction and subsequent recovery correlates with a change in electrical impedance at relevant acupuncture points. [5-8] Emerging evidence indicates that in addition to therapeutic effect, APs may also have diagnostic properties.

Chinese meridian system consists of twelve major meridians that either start from or end at the tips of the toes and fingers. The APs at the toes and fingers are the common APs to obtain electrodermal measurement. Electroacupuncture according to Voll (EAV) is a diagnostic technique with its own meridian system complimentary to traditional Chinese meridians. [1] Although the blue print of EAV system is Chinese meridian, Voll discovered eight additional meridians, many new APs and new functions of existing APs. EAV meridians and APs were named with Western physiologic systems and tissue types. Chinese and EAV meridian systems have been previously compared for their nomenclature, point location and associated functions. [9]

The APs from both systems can be used to diagnose diseases through measuring electrodermal activities. [9-11] Although testing instruments of the two systems vary in their recommended testing sites, probe design, and electrical parameters, their testing methodologies are similar. They also share common barriers that make this technique a subject of controversy and skepticism. [10] One of the most important barriers is the lack of rigorous clinical studies to assess their validity. In the past years studies have shown that electrodermal testing using both EAV
and Chinese meridian system are accurate and reliable tool to measure electrodermal activities in APs. [10, 12] There have also been pilot studies using either systems correlating electrodermal testing with pathophysiological conditions [11, 13-15] as well as evaluating therapeutic practices. [16, 17] A 60-case retrospective study showed that specific changes in EAV testing from Lung and Lymphatic meridians were correlated to lung and upper respiratory symptoms, respectively. [9] More rigorous clinical studies are certainly needed to validate electrodermal testing for APs.

The other important barrier of this technique is the lack of experimental research that reveals the physiologic basis for the testing. The EAV belongs to an area of research known as electrodermal activity, a.k.a. galvanic skin response, or sympathetic skin response (SSR). [18] The SSR represents an electrical potential generated in skin sweat glands. [19] It originates by activation of the SSR reflex arch evoked by a variety of internal or externally stimuli. The effectors of the reflex arch activate eccrine sweat glands with cholinergic mediation. [20] Sympathetic nervous system is responsible for up- and down-regulating many homeostatic mechanisms in living organisms. Sympathetic nerve fibers innervate tissues in almost every organ and system. Thus, it is reasonable to hypothesize that the change in SSR may also reflect homeostasis of each associated organ, system and tissue type.

Time-varying analysis of electrodermal activity during exercise has been studied. Posada-Quintero et al. reported a shifting of the sympathetic dynamics to higher frequencies in the electrodermal signal when subjects undergo physical activity. [21] Effect of physical exercise on electrodermal activity of APs has also been studied. Garoppo reported that aerobic running exercise induced an overall increase in electrodermal activity of APs for all 6 hand meridians but not for foot meridians using a Chinese meridian measuring system, AcuGraph. [22] Pontarollo also tested 4 APs on hand for Chinese meridians of Lung, San Jiao and Heart, plus a negative control, during physical exercise with a German digital multi-meter ET and reported an increase of electrodermal activity of Heart meridian only. [23] Both studies examined Chinese meridian system with different measuring equipment and reported a possible increase of electrodermal activity on hand meridian(s). However, effect of exercise on electrodermal activity of the EAV system has never been studied.

Aerobic-running exercise is a stress to cardiovascular, nervous, endocrine and respiratory systems. Nether studies were able to link physical stress to specific meridians that reflect complete physiological stress profile. It is probably due to the lack of meridian specificity of Chinese meridian system and/or improper equipment used in the study. The objective of this study is to test the feasibility of examining the effect of exercise-induced stress on electrodermal activity of APs with a standardized EAV system, which provides more detailed meridian profile directly linked to Western physiologic systems. It is also interesting to know which meridian(s) is activated or stressed with an EAV system.

Skin blood vessels and sweat glands are both regulated by sympathetic efferent C fibers. Skin blood vessels, controlled by sympathetic vasomotor response (VR), regulate convective transfer of heat to skin; whereas the sweat production, controlled by SSR, regulates evaporative heat from skin. [24, 25] Co-activation of SSR and VR in hands was found during rhythmic breathing and Valsava maneuver with simultaneous measurement of SSR and VR. [24] The electrodermal activity of APs is believed to be innervated by SSR. The other objective of this study is to examine, upon exercise, the correlation of electrodermal activity of APs with skin temperature, controlled by SSR vs VR, respectively.
2. Materials and Methods

One healthy subject, 55 years-old Asian male with no medication taking history, participated in the study. The procedure of the study is shown as a flowchart in Figure 1. The subject rested quietly for 5 minutes. Physical signs including heart rate (HR), blood oxygen level (O2), breathing rate (BR), skin surface temperature (Temp) of forehead, bilateral hands and feet were tested. HR and O2 were measured from the left index finger with the Pulse Oximeter (Model: CMS50D) manufactured by AccuMed. Temp was obtained from the center of the forehead, dorsal side of both hands and feet with the Dual Mode Thermometer (Model: DMT-116A) manufactured by IProven. The testing was done in an air-conditioning room with a temperature set to 77 degree Fahrenheit. EAV testing was performed using a computerized EAV instrument, MSAS Professional with a software version 1.45, manufactured by the Biomeridian Corporation, Utah. The control measurement points (CMPs) for all 40 meridians were tested. Then, a 20-minute run was performed with a Borg Rating of Perceived Exertion Scale (RPE) 12-13, indicating a moderate intensity activity. Immediately after running stopped, subject’s HR, O2, BR and Temp were tested again. EAV testing was also performed. Totally 15 sessions of the experiment were conducted on 15 different days within three month period.

![Figure 1](image)

**Figure 1** Procedure Flowchart. Procedure of the experiment is shown in the flowchart. Activities and tests are listed from the start to the end. The tests included heart rate (HR), blood pressure (BP), blood oxygen level (O2), skin temperature (Temp) and EAV testing.

EAV testing was performed according to manufacturer’s instruction by an experienced EAV practitioner. The testing is an exosomatic recording with direct current of 6–12 μA. While the testing subject holding the grounding bar, the tester pressed the probe against the skin of the acupuncture point to be measured with constant pressure for about 2 seconds till the reading is stabilized. The detailed measurement procedure was described previously.[9] Ideal balanced reading of EAV would be at 50 with a scale of 0–100. Imbalanced reading is either above or below 50, meaning stressed or weakened energy status, respectively. The further away from the number
50, the worse the imbalance would be. To analyze the testing results, the Arbitrary Measurement Value (AMV) was used. AMV is the absolute value of EAV reading (E) subtracting 50:

\[ AMV = |E - 50| \]

AMV was designed for statistical analysis and data comparison only with no clinical value. Statistical analyses, such as the mean, standard deviation (SD), and paired t-test were performed using Microsoft Excel, version 2013.

3. Results

Some minor discrepancies in EAV reading were found between left and right meridians. Comparison of the lateral meridian readings was not the aim of this study. Thus, an average readings from the left and right meridians was used for analysis. EAV testing results were summarized in Table 1 and illustrated in Figure 2. An overall increase in EAV reading was observed for the hand meridians except for Large Intestine (LI). However, there are significant effects of only five hand meridians, Lymphatic system (LY), Lungs (LU), Nervous system (NE), Endocrine system (TW) and Heart (HE), \( t(25) = -8.16 \), \( t(21) = -11.25 \), \( t(21) = -4.01 \), \( t(20) = -3.35 \) and \( t(25) = -6.05 \), respectively, \( p < 0.01 \), with the post-exercise receiving higher score than the pre-exercise. No significant change in EAV reading was found for other hand meridians and the foot meridians. The result clearly indicates that the five specific hand meridians responded to exercise significantly while the other meridians did not.

Table 1 EAV Testing before and after exercise.

<table>
<thead>
<tr>
<th>Meridians (Hand)</th>
<th>Pre-Exercise AMV (N=15)</th>
<th>Post-Exercise AMV (N=15)</th>
<th>Meridians (Foot)</th>
<th>Pre-Exercise AMV (N=15)</th>
<th>Post-Exercise AMV (N=15)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>LY*</td>
<td>2.97</td>
<td>1.32</td>
<td>8.03</td>
<td>1.91</td>
<td>PA/SP</td>
</tr>
<tr>
<td>LU*</td>
<td>1.83</td>
<td>0.96</td>
<td>8.20</td>
<td>1.89</td>
<td>LV</td>
</tr>
<tr>
<td>LI</td>
<td>1.63</td>
<td>1.37</td>
<td>1.53</td>
<td>0.81</td>
<td>JO</td>
</tr>
<tr>
<td>NE*</td>
<td>2.00</td>
<td>1.45</td>
<td>5.30</td>
<td>2.71</td>
<td>ST</td>
</tr>
<tr>
<td>CI</td>
<td>1.43</td>
<td>1.20</td>
<td>2.37</td>
<td>1.64</td>
<td>FI</td>
</tr>
<tr>
<td>AL</td>
<td>1.70</td>
<td>1.12</td>
<td>3.07</td>
<td>1.58</td>
<td>SK</td>
</tr>
<tr>
<td>OR</td>
<td>1.93</td>
<td>1.21</td>
<td>2.47</td>
<td>0.99</td>
<td>FA</td>
</tr>
<tr>
<td>TW*</td>
<td>1.47</td>
<td>1.09</td>
<td>3.70</td>
<td>2.24</td>
<td>GB</td>
</tr>
<tr>
<td>HE*</td>
<td>3.17</td>
<td>1.27</td>
<td>6.77</td>
<td>1.82</td>
<td>KI</td>
</tr>
<tr>
<td>SI</td>
<td>2.00</td>
<td>1.05</td>
<td>3.13</td>
<td>1.95</td>
<td>UB</td>
</tr>
</tbody>
</table>

*- Significant increase after exercise (\( P < 0.01 \)). LY-Lymphatic system, LU-Lungs, LI-Large intestine, NE-Nervous system, CI-Circulatory system, AL-Allergy, OR-Organ system, TW-Endocrine system, HE-Heart, SI-Small intestine, PA-Pancreas, SP-Spleen, LV-Liver, JO-Joints, ST-Stomach, FI-Fibroids, SK-Skin, FA-Fatty tissue, GB-Gallbladder, KI-Kidney, UB-Urinary bladder.
Figure 2 EAV Testing Before and After Exercise. EAV testing before and after exercise is plotted with means and standard errors. Abbreviations are LY-Lymphatic, LU-Lung, LI-Large intestine, NE-Nervous system, CI-Circulation, AL-Allergy, OR-Cellular metabolism, HE-Heart, SI-Small intestine, SP-Spleen, PA-Pancreas, LV-Liver, JO-Stomach, ST-Stomach, FI-Fibroid tissue, SK-Skin, FA-Fatty tissue, GB-Gallbladder, KI-Kidney and UB-Urinary bladder.

Table 2 Bio Signs before and after Exercise.

<table>
<thead>
<tr>
<th>Bio Signs</th>
<th>Pre-Exercise (N=15)</th>
<th>Post-Exercise (N=15)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart Rate (bpm)&lt;sup&gt;1,2&lt;/sup&gt;</td>
<td>Mean 71.87, SD 2.90</td>
<td>Mean 124.20, SD 4.72</td>
</tr>
<tr>
<td>Breathing Rate (cpm)&lt;sup&gt;1,2&lt;/sup&gt;</td>
<td>Mean 14.73, SD 0.44</td>
<td>Mean 23.93, SD 2.21</td>
</tr>
<tr>
<td>Oxygen Level (%)</td>
<td>Mean 98.20, SD 0.40</td>
<td>Mean 98.07, SD 0.25</td>
</tr>
<tr>
<td>Temperature, Hands (°C)&lt;sup&gt;2&lt;/sup&gt;</td>
<td>Mean 35.94, SD 0.12</td>
<td>Mean 35.34, SD 0.15</td>
</tr>
<tr>
<td>Temperature, Feet (°C)&lt;sup&gt;2&lt;/sup&gt;</td>
<td>Mean 35.59, SD 0.10</td>
<td>Mean 36.87, SD 0.10</td>
</tr>
<tr>
<td>Temperature, Forehead (°C)&lt;sup&gt;2&lt;/sup&gt;</td>
<td>Mean 36.84, SD 0.06</td>
<td>Mean 36.64, SD 0.17</td>
</tr>
</tbody>
</table>

<sup>1</sup>-Bpm-beats per minute; cpm-cycle per minute; SD-standard deviation.
<sup>2</sup>-Significant difference between Pre and Post-exercise results (P<0.01).
The changes in bio signs, HR, BR, $O_2$, and Temp, mean with standard deviation for the 15 sessions before and after exercise were summarized in Table 2. The HR and BR increased markedly after exercise, which is expected and a validation to sympathetic stress induced by exercise. Blood oxygen level showed no obvious change as expected. No bilateral difference was found in skin temperature readings. Thus, an average from the left and right readings were used for analysis. The changes in skin temperature for hand, foot and forehead were illustrated in Figure 3. There was a significant effect for foot skin temperature, $t(28) = -34.52, p<0.01$, with post-exercise receiving higher score than pre-exercise. It indicates that foot skin temperature increased significantly after exercise. However, there were also significant effects for hand and forehead skin temperature, $t(28) = 11.47$ and $t(28) = 4.13$, respectively, $p<0.01$, with pre-exercise receiving higher score than post-exercise. It indicates that hand and forehead temperature decreased slightly but significantly after exercise.

4. Discussion

4.1 Increase of Electrodermal Activity in Five EAV Hand Meridians after Exercise

Exercise increases heart rate and respiratory rate due to the activation of the sympathetic nervous system and the release of catecholamines. [26] Thus, exercise is considered a stress to respiratory, heart, nervous and endocrine systems. In the meantime, sympathetic stimulation may inhibit the function of other internal organs such as liver, spleen, pancreas, stomach, gallbladder, kidney and urinary bladder. In addition to the autonomic effects of exercise, blood is
usually shunted away from the digestive tract toward the skeletal muscles. [27] This study showed that aerobic running significantly raised HR and BR, a clear sign of sympathetic arousal.

This study is consistent with the previous findings from Garoppo [22] and Pontarollo [23] but provide further specificity of the meridians by showing significant increase in electrodermal activity of LY, LU, NE, TW and HE. The foot meridians remained unchanged. It has been previous documented that LY and LU meridians are connected to upper respiratory tissues and lungs, respectively. [9] Chinese meridian Triple Warmer (TW) is renamed as Endocrine system in EAV. The result of the increase in electrodermal activity for meridians of respiratory, nervous, endocrine systems and the heart is consistent with expected physiologic responses for exercise-induced stress. It indicates that EAV may be a useful tool to test functions and stresses of corresponding organs and systems.

4.2 Skin Temperature, Perspiration and Electrodermal Activity of APs

Skin temperature directly correlates to skin blood flow, which is controlled by thermoregulatory system and sympathetic VR. [28] Fall in skin temperature during exercise has been observed and reported. [29] The possible reason for the temperature drop has been suggested to be reflex-induced vasoconstriction but not thermoregulatory vasodilation, such as evaporation due to skin perspiration. [29] Increased skin blood flow during exercise may add to the demands on cardiac output and confers additional circulatory strain. Thus, it is reasonable to believe that the decrease in skin temperature is simply a physiologic adaptive response to reduce cardiovascular stress during exercise. The increase of foot skin temperature in this study is probably due to waring of shoes that prevented heat dissipation during exercise.

The regulatory mechanism for skin temperature during exercise is not the aim of this study. However, it is interesting to combine the data of EAV testing and skin temperature. Results show an increase in EAV reading in 5 hand meridians but a decrease in hand skin temperature, an activation of SSR but not VR in hands. It clearly indicates that VR and SSR may be inversely correlated during exercise. This result is consistent with the finding by Litscher et al., [8] showing that skin resistance of an AP is lower than a non-AP but the thermography measurements of the two spots remain the same. It strongly suggests that electrodermal activity and skin temperature are controlled independently with different mechanisms. Future studies with better design and large sample size is needed.

Electrodermal potential is thought to originate from skin sweat glands through SSR innervation and the increase of the electrodermal activity is due to the increase in sweat secretion. However, this study showed an increase in electrodermal activity in hands with a decrease in skin temperature. In the meantime, there was no change in electrodermal activity in feet but an increase in skin temperature, which results in much more perspiring in feet than hands. This finding suggests that the increase in electrodermal activity may not be a result of more perspiration, but likely a direct increase in electrical potential of sympathetic nerve endings. More research is needed to verify the finding.
4.3 Possible Physiologic Mechanism of EAV

Emerging evidence indicates that APs in fingers and toes may have diagnostic properties via EAV testing. This study reported that exercise-induced sympathetic arousal for heart, respiratory, nervous and endocrine systems can be detected with EAV testing from corresponding hand meridians, probably via SSR innervation. The results of the study suggests that 1) SSR innervation may be meridian specific, meaning that each meridian may correspond to specific organ or tissue; 2) SSR may respond to exercise-induced stress independently from VR system, and 3) Skin temperature and perspiration may not affect EAV testing.

Physiologic mechanism of EAV testing is further postulated in Figure 4. Stimuli such as exercise and/or diseases to the organ (Lungs) trigger stress signal sent to central nervous system via afferent nerve (1) of the sympathetic reflex arch. Autonomic response to the stress is sent to effector organ through sympathetic efferent nerve (2a). In the meantime, sympathetic activation can be detected using EAV devices from corresponding APs (2b). Innervated by sympathetic C fiber, SSR and VR can be activated simultaneously or independently. The specific response patterns may depend on the type, degree, location and duration of the stress. More research to address detailed physiologic mechanism is warranted.

![Figure 4 Possible Mechanism of EAV Testing.](image)

4.4 Limitations of this Study

Several limitations can be found in this study. 1) The study included only one testing subject, whose physiologic response to stress may be biased. Although the subject was healthy with no detectable diseases and medication taking history, and the 15 experimental sessions were done in as long as three-month period, the result may still represent physiologic response from this
particular subject. It is interesting to know if the response pattern can be reproduced with more testing subjects in future studies. 2) EAV meridian testing seems to reflect only the tonic component of the electrodermal activity. With some spectral limitations, EAV is unable to distinguish tonic and phasic signals nor provide frequency information during testing. However, up till now EAV is still one of the only few systems that specialize in detection of electrodermal activity of acupuncture points and can be used and obtain meaningful results in clinical practice. 3) EAV testing in the study was done by only one tester. It is known that EAV reading may vary among different testers depending on their training, experience and technique. Multiple testers may be included in future studies to examine the variance from different testers and reproducibility of the technique. Future studies with larger sample size and better design are warranted.

4.5 Clinical Benefit of Using EAV Testing

Chronic diseases may progress through a pathway from a less-severe stage with an energetic imbalance to more-severe stages with biochemical changes and histologic damages. Most popular medical tests, such as blood chemistry and imaging techniques, are perfect for identifying biochemical and histologic changes, but leave a gap between the healthy and diseased stages. This gap, also known as suboptimal health, is recognized by holistic medicine proponents as the stage of energetic or functional imbalance. EAV testing is a perfect technique to fill this gap by detecting stresses of organs and tissues through meridian connections via SSR innervation. EAV testing is a simple, fast, noninvasive inexpensive technique and is perfect for screening for pre-disease conditions, which may not be reflected from patient’s complaints and history. With a complete meridian balancing profile in hand, holistic clinicians will make better clinical judgments in terms of diagnosis, protocol design, and treatment assessment, and, certainly, could produce better clinical outcomes, thus, achieve true holistic and personalized medicine.

5. Conclusion

Despite the limitations of the study, significant increase in electrodermal activity of hand meridians LY, LU, NE, TW and HE was found after exercise. Significant increase in foot temperature and decrease in hand and forehead temperature was also observed. The finding is consistent with expected physiologic response to running exercise and it suggests that EAV can be used to detect stresses from corresponding organs and tissues. The finding also suggests that electrodermal activity of APs is likely to be controlled independently from skin temperature and perspiration. The study concludes that it is feasible to carry out large-scale study to further examine the effect of exercise on electrodermal activity with standardized EAV system. To further assess physiologic basis of EAV testing, additional clinical and mechanistic studies are warranted.

Author Contributions

The author did all work for this paper.

Competing Interests

No competing financial interests exist.
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Modernization of Acupuncture Education in Europe and China: A Report from Austria

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Abstract
The present report deals with some current important aspects of traditional Chinese medicine (TCM) education and practice in Europe and China. The data and facts are based on a lecture of one of the authors (G.L.) prepared for a conference in Wuhan about acupuncture education in Europe, and lectures of two high-ranking representatives of renowned Chinese institutions (State Administration of TCM and Heilongjiang University of Chinese Medicine, Harbin). In addition to current figures regarding TCM in general, the advantages of TCM are reported, and special cooperations of the important university in the North of China are introduced.

Keywords
Acupuncture; education; practice; Europe; Austria; China; modernization
Acupuncture in Europe

Acupuncture is the best-known and most widespread part of traditional Chinese medicine (TCM) in the western world. Acupuncture as a distinct therapeutic system is recognized by law in 12 European Union (EU) member states (Austria, Belgium, Bulgaria, Czech Republic, Denmark, Germany, Greece, Hungary, Latvia, Portugal, Slovenia and Spain; Figure 1) [1].

Figure 1 Acupuncture in the European Union (modified from [1]).
In Austria, Bulgaria, the Czech Republic, Greece, Hungary, Latvia, Slovenia and Spain, only medical doctors are allowed to perform acupuncture. In Belgium and Portugal the law does not explicitly exclude non-medical practitioners, but this has not yet been implemented. In Denmark, everyone, both individuals with and without a medical authorization, is allowed to perform acupuncture for therapeutic purposes. In Austria, Bulgaria, Germany, Italy, Portugal, Spain and Switzerland the diplomas of medical acupuncturists are issued by the national medical association/chamber/council, in other countries usually by the national medical acupuncturists’ association. Diplomas issued by the national medical acupuncturists’ association are officially approved by the government in Latvia and are recognized by the national medical council/chamber in the Czech Republic and Italy. Approximately 80,000 medical doctors in the European Union have undergone training and education in acupuncture [1].

Special Situation in Austria

Since 1986, acupuncture is officially acknowledged as a scientific cure in Austria. According to data from 2011, 3531 doctors hold the acupuncture diploma from the Austrian medical association [2], but today there will be a lot more. Exemplarily, these associations in Austria are allowed to teach the ÖÄK acupuncture diploma course: “Doctors for Acupuncture” (Vienna), “Austrian Society for Acupuncture” (Vienna) and “Austrian Society for Controlled Acupuncture and TCM” (Graz). The goal of such TCM courses is to teach knowledge and skills in acupuncture in theory and practice. The audience consists of general practitioners and medical specialists of all subjects. Students of medicine can start the diploma education during the last study section. This advanced education takes at least 18 continuous months and includes 180 teaching units (TUs). The course is divided into 120 theoretical and 60 practical TUs. The practical part of the education should last at least nine months and can only be started after at least 70 TUs of basic education. A maximum of 20 TUs of practice can be done on two consecutive days. Students will be credited 20 TUs of practice for working in a non-German speaking country for at least three weeks. A maximum of 10 TUs (45 minutes each) will be held. During the first 120 TUs (theory part) some basic practice aspects will also be taught, for example searching for points, needling or palpation [3].

The curriculum of Block I contains the following topics: systematics of the organic systems of the ventral circulation with acupuncture points, introduction of the medical history of TCM, presentation of acupuncture-relevant basics of TCM, systematics of the organic systems of the dorsal circulation with acupuncture points, systematics of the organic systems of the lateral circulation with acupuncture points, conception vessel, governing vessel, extra points of acupuncture, ear acupuncture I, further microsystems, pain (pain acupuncture, acute pain, chronic pain), acupuncture of the musculoskeletal system, inner dysfunctions I “TCM”, inner dysfunctions II “TCM”, science and research (overview of the most important acupuncture studies on different diseases, how to plan acupuncture studies (ethics committee, randomization, double-blinding...), placebo/sham acupuncture), repetition of knowledge of acupuncture points and practice of acupuncture. Block II consists of the so-called free theory: psychosomatic medicine, neurology, psychiatry, ear-nose-throat, midwifery/gynecology/urology, pediatrics, ophthalmology, and ear acupuncture II, hand acupuncture and other microsystems; introduction to Chinese drug therapy [3].
There are 60 TUs of practice seminars and 10 TUs about basics in practical application of acupuncture (conversation, anamnesis, treatment strategies, application of lasers, point selection). 30 TUs are used for clinical education in patients in a clinic or practice, another 20 TUs are dedicated to clinical education in patients of special fields [3].

The earliest possible date for the final examination is 18 months after starting the advanced education. This period of time is necessary to study the basics and to strengthen the practice skills. For doctors who are members of the medical association in Austria, there is a fee of about 50 Euro to pay [3].

**Acupuncture at Universities in Europe**

Familiarization courses about acupuncture are provided in the medical undergraduate curriculum as part of a course on Complementary and Alternative Medicine in the Czech Republic, Germany, Hungary and the Netherlands; as a separate subject in Austria, Bulgaria, France, Germany, Hungary and Spain; and as a part of Traditional Chinese Medicine in Germany and Latvia. Familiarization courses are optional for medical students in the Czech Republic, France (one university), Germany, Hungary (one university) and Switzerland (some universities), obligatory in the United Kingdom. Postgraduate training courses in acupuncture for doctors are provided at universities in the Czech Republic, France, Hungary, Latvia, Portugal and Spain, in other countries at private teaching centers. Acupuncture is an official part of the Continuous Education Program for doctors in Germany, Greece, Hungary and Latvia. A professorial chair of acupuncture exists in Bulgaria (Sofia), Hungary (Pécs) and Latvia, a chair of CAM including acupuncture in France (Nantes), Germany (Berlin), Switzerland (Bern) and the United Kingdom (Exeter, Sheffield, Thames Valley, Southampton). In Austria (Vienna, Innsbruck and Graz), single centers and/or departments dealing with TCM research exist at Medical Universities. Acupuncture research in Austria exists mainly at Medical University of Graz (see Figure 2) [1].

![Diagram of the High-tech Acupuncture Network](attachment:Figure_2.png)

**Figure 2** High-tech acupuncture research network initiated by Medical University of Graz.
As acupuncture continues to grow in Europe, hospitals and western health institutions increasingly incorporate medical acupuncturists as staff members of the institutions or as contractual providers. In Germany there are several hospitals providing TCM, including acupuncture (Figure 3).

![Acupuncture in European hospitals](image)

Figure 3 Acupuncture in hospitals in Germany and Austria.

**General information about TCM education in China [4-6]**

A very interesting TCM symposium entitled "International Conference on Health, Healthcare and Eco-Civilization" was held at London Southbank University on September 5 and 6, 2015 (Figure 4). The conference was organized by the China Academy of Culture, London South Bank University and the London Confucius Institute for TCM. During the session "Public health, healthcare and disease prevention", which was moderated by the co-author of this article, the Director of the International Education College of Heilongjiang University of Chinese Medicine in Harbin, Prof. Wang Ai-Ping, spoke about the current situation of TCM education and practice in China. In addition Prof. Cao Hong-Xin, the Director General of the Department of Science and Technology of the State Administration of TCM, P.R.C., reported on the development of TCM in China [5]. Some important aspects are summarized in this paper.
The lecturers from China reported that TCM and Western medicine are equally important in China's medical care and are considered equivalent in the Chinese health policy. They presented the following general facts about health care in the world’s most populous country: In the People’s Republic of China, a total of 3,732 TCM hospitals exist with 755,050 hospital beds. Each year, approximately 515 million outpatients are treated in China, and 22.27 million people are hospitalized. There are also 39,854 TCM clinics that serve 128 million outpatients.

It is an interesting fact that according to a report of the United States and the World Health Organization (WHO), only 5% of the population are considered “healthy”. Persons classified as “subhealth syndrome” constitute 75%, and about 20% of the population suffer from at least one disease.

Figure 5 illustrates the advantages of the TCM when compared with conventional treatment methods. TCM is efficient especially in the subhealth area and when the first clinical symptoms manifest. In severe diseases, TCM is usually used as an additional treatment.
In the last 60 years a lot of energy has been invested in the development of higher education in the field of TCM in China. Already in 1956 the first colleges for TCM were established. Afterwards a total of 24 independent TCM colleges emerged. In addition, 62 institutions specifically dedicated to TCM training were established. Over 300,000 TCM practitioners were already trained at these colleges, which is also of great importance for global health care.

Immediately after the founding of the People’s Republic of China, the country attached great importance to the development of TCM. Following the model of medical education in the former Soviet Union, important changes were implemented in the education system, with the target to ensure better and higher education in TCM. Especially in the 21st century, the training underwent many reforms. The implementation of clinical medicine into professional TCM training, both the master and doctor’s degree were divided into special grades of Medical Science and "TCM professional degree". In recent years, the practical TCM education was completely redesigned, and excellently trained TCM practitioners were educated thanks to medical cooperations as well as cooperations among universities. The TCM training includes five years of study; three more years are designated to provide standardized training. A total of eight years will be needed for the full completion of the training to become a TCM doctor.

TCM education for students contains the integration of TCM in modern science, and the integration of TCM in western medicine. Furthermore, TCM training includes the integration of humanities, social and natural sciences. There are compulsory courses such as a basic course in humanities and social sciences, foreign languages, sports units, information sciences, basic courses in TCM, basic courses in clinical TCM, basic courses in western medicine, clinical courses for TCM and clinical courses for western medicine. There are also optional subjects such as specific scientific methods and specialized courses of clinical TCM and western medicine including prevention and rehabilitation.

The Chinese Ministry of Education has recently issued a regulation entitled "Reforms of teaching contents and curricula of the higher education system in the 21st century", 15 regulations of which are allotted to TCM. Based on that, a number of reforms were carried out in the curriculum of TCM. Interdisciplinary curricula were created and national performance rates were introduced. At the same time the production of textbooks has been accelerated; seven versions of TCM textbooks are now used at higher universities. These policies are not only the framework of basic education and clinical practice, but also led to a coherent education system in TCM.

Internationalization is increasingly becoming one of the most important strategic objectives in the reform and development of higher education in the 21st century. The higher education of TCM has already begun this process of internationalization. About 3,000 foreign students come to China to learn TCM, representing the largest part of exchange students.

In the following, TCM training at Heilongjiang University of Chinese Medicine will be presented in more detail. Foreign students whose Chinese language skills are on HSK level 5 (knowledge of 2500 Chinese characters needed; able to easily read a Chinese newspaper and to follow a film), can study together with Chinese students, using the same textbooks and taking the same courses (exempt political education), and the same tests must be completed together with Chinese students. In addition, the course "Chinese in TCM" was founded to combine the knowledge of TCM and Chinese. Learning Chinese is seen as the main goal and the knowledge of TCM as a secondary objective to increase the learning effectiveness.
For students who have not previously learned Chinese, an English version of the textbooks is offered. They attend a separate class, and are taught by specially trained bilingual teachers; if necessary, a translator is consulted. Most of these students specialize in acupuncture and massage.

In 2008, a cooperation was started with the Southwest Acupuncture College (USA). At Heilongjiang University the practical clinical training of American students takes place. Students have the opportunity to visit different areas in the connected hospitals and also to practice there, for example: acupuncture, massage, rehabilitation, Chinese internal medicine and four English-language lectures on Chinese medicine. After successful completion of all internships, the students receive a certificate.

Since 1999, Heilongjiang University cooperates with the TCM school in Kuala Lumpur (Malaysia) in a 5-year medical academic education without a doctorate degree. The two universities jointly develop a plan for training and teaching programs. The students receive a diploma and a certificate from Heilongjiang University. Requirements are the completion of the full course of study and passing all tests.

In 2010, the cooperation with Semmelweis University in Budapest (Hungary) began. It is a five-year course. The first four years are spent in Hungary with mostly theoretical courses; the last year is carried out as a practical year at Heilongjiang University. This course is taught in English.

In 2014, Heilongjiang University has started a cooperation with the Merchants Association of Chinese Herbs in America to set up a 4-year degree program in the field of pharmacy in San Francisco. The study plan is designed based on the American education system. In the first two years, students learn about pharmacy in the United States, in the other two years there are laboratory courses, internships and case studies to be completed. At Heilongjiang University, qualified teachers from the region give the lessons; on the other hand, outstanding teachers are sent to America. For this course the students receive a diploma and degree certificate from Heilongjiang University of Chinese Medicine.

Now we are faced with an optimistic situation: TCM is becoming more and more popular in the world, and its basic medical concepts of holistic health and their clinical benefits are recognized by more and more people. There are TCM doctors and educational institutions all over the globe, and there is much collaboration in this field.

TCM as an important part of medical sciences constitutes a promising branch of the global economy. The development of TCM will move towards globalization through its increasing influence on the international community. It is therefore necessary to standardize TCM training. Not only will practical TCM training be uniform worldwide, the development and quality of all TCM schools will also be improved. The target is the globalization of TCM.

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Author Contributions

DL performed data research and drafted the manuscript. GL designed the underlying lecture and the article, and performed critical revision of the article.

Competing Interests

The authors have declared that no competing interests exist.

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