Clinical Observation

The infrared radiation spectrum of acupoint Taiyuan (LU 9) in asthma patients

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Abstract

OBJECTIVE: To analyze the distinctive pathological characteristics in the spectrums of spontaneous infrared radiation at the Taiyuan (LU 9) acupoint in patients with asthma.

METHODS: A highly sensitive infrared spectrum detecting device was used to detect the spectrums of spontaneous infrared radiation at Taiyuan (LU 9) in 37 asthma patients and 34 healthy volunteers.

RESULTS: Asthma patients had significantly lower infrared intensity than that of the healthy volunteers ($P>0.01$). Asthma patients had significantly lower overall infrared radiation intensity at the left Taiyuan (LU 9) than that of healthy volunteers ($P>0.05$), but there was no significant difference between healthy volunteers and asthma patients at the right Taiyuan (LU 9) ($P>0.05$). The infrared radiation intensity of 17 wavelength spots at the left Taiyuan (LU 9) and 4 wavelength spots at the right Taiyuan (LU 9) in asthma patients were significantly lower than those of healthy volunteers ($P>0.05$). At 2 μm, the infrared radiation intensity of asthma patients was significantly stronger than that of healthy volunteers ($P>0.05$). At 19 wavelength spots in the healthy volunteers and at 4 wavelength spots in the asthma patients, the left Taiyuan (LU 9) showed a significantly stronger intensity than that of the right Taiyuan (LU 9) ($P>0.05$). By Pearson’s $\chi^2$ test, healthy volunteers had more wavelength spots that were significantly different between the left and right Taiyuan (LU 9) than the asthma patients ($P>0.01$).

CONCLUSION: Changes in the infrared spectrum at the Taiyuan (LU 9) acupoint in asthma patients may reflect distinct pathological changes. Certain acupuncture points may be related to specific organs.

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Key words: Infrared radiation; Spectrum; Asthma; Acupoints; Taiyuan (LU 9)

INTRODUCTION

Infrared spectroscopy is the subset of spectroscopy that involves the infrared region of the electromagnetic spectrum. This includes absorption spectroscopy, such as the Fourier transform spectrum and emission spectrum, which can be used to identify compounds and investigate sample composition. In the present study, we investigated the emission spectrum of spontaneous infrared radiation in the human body.
According to physics, any object with a temperature above absolute zero (-273°C) may show infrared radiation. Therefore, the human body is a natural infrared radiant point that emits 1-30 m constant infrared spectrum. The physiological activity of the body involves thousands of biochemical reactions that constantly emit infrared photons from the surface of the body\[^2\]. The infrared photon is a type of information carrier which provides information for various levels of life activities, such as oxidative metabolism, information transfer, photosynthesis, cell division, cancer, cell apoptosis, and regulation of cell growth\[^2\]. Infrared radiation of the body reflects metabolic changes in the organs and tissues of various parts of the body.

Concerning infrared characteristics of the human body, most research has investigated the infrared temperature of the body, and infrared radiation imaging techniques are the most commonly-used methods\[^1\]\. However, the temperature of the body surface is greatly affected by physiological factors, such as sweating and environmental factors, such as cross-ventilation. Therefore, infrared radiation imaging techniques, which mainly detect the temperature of the body surface, have certain limitations. Out of the total spontaneous infrared radiation of the living body, more than 90% is thermal radiation; therefore, a great deal of information can be obtained by the body temperature. However, the infrared emission spectrum can reveal subtle changes and offset the disadvantage of infrared radiation imaging techniques. In the present study, a newly developed infrared radiation spectrum detecting system was used, which features high sensitivity, low noise, a wide wavelength range, and stable performance\[^7\] -\[^9\].

Acupuncture points are points for puncturing but they are also points that can reflect diseases\[^10\]\. According to the traditional Chinese medicine (TCM) meridian theory, Taiyuan (LU 9) is one of the major points on the lung meridian and also the major acupuncture point for treating diseases of the lung. It is located at the transverse crease of the wrist and on the radial artery, which is the site for pulse-diagnosis in TCM practice\[^11\]\. The purpose of the present study was to determine whether the infrared radiation spectrum at the Taiyuan (LU 9) acupoint in patients with asthma is different from that of healthy volunteers.

### METHODS

#### Subjects

Thirty-seven asthma patients (aged between 18 years and 72 years and with an average age of 49.9 ± 14.18 years) who met the diagnostic criteria of asthma set by the Respiratory Disease Branch of Chinese Medical Association (CMA)\[^12\]were recruited through the referral of doctors in the Respiratory Disease Department of Longhua Hospital affiliated with Shanghai University of Traditional Chinese Medicine, and all the patients were in the stage of remission. Thirty-four healthy volunteers (aged between 20 years and 56 years and with an average age of 30.2 ± 9.57 years) were recruited as the controls. The word “healthy” means that the subjects had a normal body temperature, but with no autonomic nervous system dysfunction, and no respiratory disease or systemic disease\[^13\]\. All the subjects were informed of the nature of the experiment and signed a consent form. The study was conducted in compliance with good clinical practices, and the research protocol was approved by the Human Study Ethics Committee of Longhua Hospital affiliated with Shanghai University of Traditional Chinese Medicine.

#### Procedures

A highly sensitive device (PHE 201) was used for detecting the spectrum of spontaneous infrared radiation on the surface of the human body (Shanghai Institute of Technical Physics of Chinese Academy of Sciences) (Figure 1). A detecting head of 3 mm in diameter was gently placed against the skin of the body. A speed-fixed wave cutter with a rotating speed between 0 and 1500 r/min was set behind the head, and its frequency signal was linked to the input end of the reference signal of the lock-phase amplifier (EG&G 5300). The infrared light is transformed into pulse signals after it passes through the wave cutter, and is spectralized by a spectrometer (Charles), irradiating on a high sensitive Hg\(_x\)Cd\(_{1-x}\)Te infrared transducer (made by Shanghai Institute of Technical Physics; chip area, 2.5 cm\(^2\), under liquid nitrogen conditions). To avoid interference, the power of the transducer is supplied by a dry battery.

Such a weak output signal of the transducer is sent to the lock-phase amplifier to be amplified, in which only the frequencies and phases are identical with the signals of the wave cutter can be amplified 100,000 times, and the rest of the signals are filtered. The amplified signals are sent to an oscilloscope and computer for observation and statistical analysis.

The experiment was performed in a quiet room with well-controlled environmental conditions (room temperature was 22±3°C, minimal air flow, and relative humidity was 45%-65%), and it was shielded from electromagnetic radiation and sunlight.

The subjects were asked to arrive at the laboratory 30 min prior to the experiment, and sat quietly with both their forearms exposed so that they could acclimatize to the testing conditions. Both the left and right Taiyuan (LU 9) acupuncture points were selected as the testing points. The detecting head was gently placed against the skin of the Taiyuan (LU 9) point. Each scan lasted 1.5 min at the left and right Taiyuan (LU 9).

While a wavelength between 1.5-1.6 m was scanned by
the infrared spectrometer, radiation intensities were recorded automatically every 0.25 m. A total of 59 wavelength spots were recorded during the 1.5 min. The operator was blinded to the group assignment.

Statistics
The SPSS11.5 software package was used for analysis, and the independent samples t-test was adopted to compare intensities of infrared radiation of Taiyuan (LU9) in the asthma patients with that of healthy volunteers. Pearson’s χ² test was used to compare the number of wavelength spots showing a significant difference between the left and right Taiyuan (LU9) in asthma patients compared with healthy volunteers. The test level α=0.05 or less was considered significant in all cases. The infrared radiation spectrum diagram was generated by Excel.

RESULTS
Figure 2 illustrates the infrared radiation spectra of Taiyuan (LU9) in asthma patients and healthy volunteers. The x-axis shows the values of the wavelength from 1.5 to 16 μm, and the y-axis shows the corresponding infrared radiation intensities (volt, V). The major radiation range was from 6.5-16 μm, with the major peak of radiation at approximately 10 μm. Further analysis of the infrared radiation intensity was performed as follows.

Comparison of infrared radiation intensity between asthma patients and healthy volunteers.
Overall, the infrared radiation intensity of the combined left and right Taiyuan (LU9) in the asthma patients was significantly lower than that in the healthy volunteers (P>0.01) The asthma patients had significantly lower general infrared radiation intensity at the left Taiyuan (LU9) compared with that of the healthy volunteers (P>0.05). However, there was no significant difference between the healthy volunteers and asthma patients at the right Taiyuan (LU9) (P>0.05, Table 1).

Of the 59 detected wavelength spots of infrared radiation intensity at the left Taiyuan (LU9), 17 wavelength spots in the asthma patients were significantly lower than those of the healthy volunteers (P>0.05; from 8.5 to 9.25 m, from 10.5 to 11.75 m, from 14 to 15.25 m, and at 16 m; Figure 3). Those wavelength spots were 8.5 m, 8.75 m, 9 m, 9.25 m, 10.5 m, 10.75 m, 11 m, 11.25 m, 11.5 m, 11.75 m, 14 m, 14.25 m, 14.5 m, 14.75 m, 15 m, 15.25 m and 16 m. Of the 59 detected wavelength spots of infrared radiation intensity at the right Taiyuan (LU9), 5 wavelength spots in the asthma patients were significantly different from those of healthy volunteers. At 4 wavelength spots, from 8.5 to 9.25 μm, the infrared radiation intensity of asthma patients was significantly lower than that of the healthy volunteers (P>0.05) At 2 μm, the infrared radiation intensity of asthma patients was significantly stronger than that of healthy volunteers (P>0.05, Figure 4).

Comparison of infrared radiation intensity between the left and right Taiyuan (LU9)
Of the 59 detected wavelength spots of infrared radiation intensity at the left Taiyuan (LU9) in the healthy volunteers, 19 wavelength spots (at 4 m, from 4.5 to 5.25 m, from 7 to 10 m and 15.5 m) showed a significantly stronger intensity than that of the right Taiyuan (LU9) (P>0.05). In the asthma patients, 4 wavelength spots (at 3.5 m, 4 m, 4.5 m and 4.75 m) of the left Taiyuan (LU9) showed a significantly stronger intensity than that of the right Taiyuan (LU9) (P>0.05). Pearson’s χ² test showed that more wavelength spots were significantly different between the left and right Taiyuan (LU9) in healthy volunteers than in asthma patients (P>0.01, Table 2).
Table 1 Comparison of infrared radiation intensity of Taiyuan (LU 9) between asthma patients and healthy volunteers (± s, V)

<table>
<thead>
<tr>
<th></th>
<th>Left</th>
<th>Right</th>
<th>Sum of the left and right</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asthma patients</td>
<td>63.03±5.70</td>
<td>63.05±4.92</td>
<td>63.04±5.29</td>
</tr>
<tr>
<td>Healthy adults</td>
<td>66.05±6.09</td>
<td>65.02±5.94</td>
<td>65.54±5.02</td>
</tr>
<tr>
<td>P</td>
<td>0.034</td>
<td>0.131</td>
<td>0.009</td>
</tr>
</tbody>
</table>

Table 2 Comparison of the number of wavelength spots with a significant difference between the left and right Taiyuan (LU 9) between asthma patients and healthy volunteers

<table>
<thead>
<tr>
<th></th>
<th>Number of wavelength spots with significant difference</th>
<th>Number of wavelength spots without significant difference</th>
<th>χ²-value</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asthma patients</td>
<td>4 (6.78%)</td>
<td>55 (93.22%)</td>
<td>12.151</td>
<td>0.001</td>
</tr>
<tr>
<td>Healthy adults</td>
<td>19 (32.20%)</td>
<td>40 (67.80%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

DISCUSSION

In recent years, infrared radiation spectrum analysis has made great progress in studies on the characteristics of the infrared spectrum of acupuncture points and the mechanism of moxibustion treatment \[7,9,14,15\]. With the highly sensitive Hg_xCd_yTe infrared transducer, near-infrared radiation below 3 μm can be detected, while previous techniques were unable to achieve this resolution. The infrared radiation imaging technique is a commonly-used method for infrared radiation characteristics of acupuncture and moxibustion. However, it focuses on thermal radiation produced by body temperature and it can only detect 3 to 6 μm of radiation, which is a narrow range, and it cannot present a complete wide-band spectrum produced by the human body in a natural state. Just as the infrared radiation spectrums shown in Figure 2, by roughly comparing we found no obvious difference in the spectrums of Taiyuan (LU 9) in both asthma patients and healthy volunteers.

The strongest intensity of spontaneous radiation is determined by Kelvin temperature with Wien’s law of displacement\[16\]. The temperature of the body surface is approximately 33°C or 306 K; therefore, the wavelength of the greatest radiation intensity of the human body should be approximately 9.47 μm. The radiation peaks emitted by Taiyuan (LU 9) in asthma patients and healthy volunteers in the current study agree with the results produced by Wien’s law of displacement and are consistent with our previous research\[7,9,14,17\] and Ovchkin’s observation\[8\].

From the view point of TCM, in the attack stage, asthma is mainly due to the preponderance of pathogens in the lung, while in the stage of remission, it is mainly due to the weakness of internal organs, especially the lung. In the present study, all patients were in the remission stage of asthma, the function of the lung was weak and the pulse was weak; therefore, infrared radiation of Taiyuan (LU 9) in the radial artery might also be weak. In the current study, asthma patients had significantly lower general infrared radiation intensity at the left Taiyuan (LU 9) compared with that in healthy volunteers. At the right Taiyuan (LU 9), there was no significant difference in infrared radiation intensity between the healthy volunteers and asthma patients. However, when comparing the general infrared radiation intensity of the left and right Taiyuan (LU 9), asthma patients had a significantly lower infrared intensity than that of the healthy volunteers (Table 2). All these results showed that the asthma patients had their infrared radiation changes in the left Taiyuan (LU 9) rather than in the right Taiyuan (LU 9). This indicates that the left Taiyuan (LU 9) plays a more critical role. Using point-to-point analysis, of the 59 detected wavelength spots at the left Taiyuan (LU 9), asthma patients had 17 wavelength spots that were significantly lower than that of the healthy volunteers, while at the right Taiyuan (LU 9), they only had 4. This finding indicated that the left Taiyuan (LU 9) had more changes than the right in asthma patients compared with healthy volunteers. Moreover, at 8.5 m, 8.75 m, 9.0 m and 9.25 m of 4 wavelength spots, compared with healthy volunteers asthma patients had a significantly lower infrared radiation intensity at both the left and right Taiyuan (LU 9). This indicates that the infrared radiation intensity of these four wavelength spots may carry characteristic pathological information in asthma patients.

When comparing infrared radiation intensity between the left and right Taiyuan (LU 9), of the 59 detected wavelength spots, 19 (32.20%) wavelength spots in healthy volunteers and 4 (6.78%) wavelength spots in asthma patients had a significantly stronger intensity of the left Taiyuan (LU 9) compared with that of the right Taiyuan (LU 9). Pearson’s χ² test showed that there were more wavelength spots that were significantly different between the left and right Taiyuan (LU 9) in healthy volunteers than in asthma patients (Table 2). This finding indicated that in asthma patients, infrared radiation was more decreased at the left Taiyuan (LU 9) than at the right Taiyuan (LU 9). In our previous studies, we found that there was an obvious difference in infrared radiation intensity between the left and right acupuncture points on the arms in healthy people\[19\]. However, divergent pathological factors af-
fected such difference in patients, similar to the asthma patients in the present study. As compared with the right Taiyuan (LU 9) the left Taiyuan (LU 9) showed more changes in the infrared radiation, it is speculated that the left Taiyuan (LU 9) can reflect conditions of the lung more sensitively. In addition, in studies on the relationship between the infrared radiation of Taiyuan (LU 9) and pulmonary function, it was found that the left Taiyuan (LU 9) showed the amount of wavelength at which pulmonary function was relevant to spontaneous infrared radiation of left Taiyuan (LU 9) was more than that on other detected locations. ($P>0.01$) [19,20].

With regard to manifestation of the left Taiyuan (LU 9) in infrared spectrum research, further studies are required to determine whether it is a phenomenon peculiar to asthma or just a common phenomenon in all lung diseases.

A limitation of this study is that only Taiyuan (LU 9) was examined, but other acupuncture points closely related to the lung were not investigated. It is unknown whether closely-related points have the same changes as Taiyuan (LU 9). Further studies are also required to determine if infrared radiation intensity returns to normal after proper treatment.

![Figure 2](image2.png)

Figure 2

![Figure 3](image3.png)

Figure 3
REFERENCES