Change in Skin Surface Temperature at the Posterior Neck when Using Acupuncture at Houxi Acupoint in Healthy Volunteers

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Abstract

Introduction
The use of acupuncture has been suggested for the treatment of neck pain. Recently, a large body of evidence has demonstrated that acupuncture has an effect on microcirculation in pain regions, but the exact mechanism remains unclear. This study aims to evaluate the skin surface thermographic changes in the posterior neck associated with manual acupuncture at the Houxi (SI-3) acupoint.

Methods
Sixty healthy volunteers of both genders, aged 18 to 30 years, were randomly determined into two groups: left acupuncture (Group A) and right acupuncture (Group B). Each group underwent two sessions with a 7-day interval. The first session involved acupuncture at the control Yuji (LU-10) acupoint, while the second session featured acupuncture at the SI-3 acupoint. Skin temperature at the posterior neck was measured using an infrared thermal camera (FLIR C5™, FLIR® Systems, Inc.) at five time points with 5-minute intervals.

Results
There were statistically significant increases in posterior neck skin surface temperature (p < 0.05) at acupuncture at both left and right SI-3 acupoint, but no significant change was observed during acupuncture at left and right LU-10 acupoint. Furthermore, acupuncture at the SI-3 acupoint on either hand increased posterior neck skin surface temperature without a statistically significant difference (p > 0.05).

Conclusion
We observed applying acupuncture at the SI-3 acupoint increased the skin surface temperature of the posterior neck area. Furthermore, the SI-3 acupoint exhibits a uniform impact on the posterior neck area's skin surface temperature, regardless of the side chosen for acupuncture.

Introduction
Acupuncture, an therapeutic technique in traditional medicine with history of development over 2500 years, has received acknowledgment from the World Health Organization for its efficacy in treating various pain conditions including neck pain [1,2]. Acupuncture is also considered to be safer and more effective for neck pain management [3]. Despite its recognition, the precise mechanism of acupuncture remains fully elucidated, and how acupoints influence remote areas necessitates rigorous scientific investigation.

The Houxi (SI-3) acupoint is the Shu-stream point of Small-Intestine channel, which is a special point of the 12 meridians, located distal to the elbows and knees, namely well, brook, stream, river and sea points. According to its special features, SI-3 acupoint is an important distal point for pain, stiffness, and contractures along the course of the channel and for disorders of the cervical spine [4]. There are two potential explanations for how SI-3 influences neck pain based on classical traditional medicine texts. The SI-3, as Shu-stream point, are primarily used to address physical fatigue, joint discomfort, and pain along the SI channel. Furthermore, SI-3 acupoint serves as the meeting point of the Governing Vessel, one of the eight extraordinary channels, and it is also connected to the Bladder channel. Consequently, according to traditional medicine theory, stimulating SI-3 acupoint can alleviate pain in areas related to the Bladder channel and pain along the Governing channel, such as headaches, back, leg, and heel pain. Additionally, SI-3 has the capacity to open the Governing channel, promote a tranquil spirit (Shen), and clear the mind, all of which can contribute to pain relief [4]. Yet, the specific mechanisms of SI-3 acupoint remains debated.
Research indicates that microcirculation plays a crucial role in neck pain, with blood flow differing between painful and painless regions. Furthermore, microcirculation, specifically blood flow in neck pain, plays a pivotal role, given significantly reduced circulation in painful regions compared to pain-free areas [5]. Acupuncture can influence FBP in remote places connected by meridians [6]. In recent times, advancements in scientific tools have enabled the use of infrared radiation thermometry (IRT) to explore acupoints, making it a non-invasive, cost-effective, and secure method [7,8]. Previous IRT research has primarily concentrated on differentiating acupoints from non-acupoint areas and monitoring temperature shifts at acupoints. Although skin temperature correlates with local microcirculation [9], limited attention has been dedicated to evaluating temperature fluctuations at specific acupoints, a group of acupoints frequently utilized in clinical settings. This study aims to elucidate the relationship between SI-3 acupoint and the posterior neck area by monitoring changes in skin surface temperature using an infrared camera during acupuncture on healthy volunteers.

Materials And Methods

Study design and participants

This was a trial conducted in the Acupuncture Experimental Research Lab, Faculty of Traditional Medicine, University of Medicine and Pharmacy at Ho Chi Minh City from October 2022 to April 2023. The protocol has been registered with the Clinical Trial Registry (NCT05581329).

To achieve a power of 0.8 at α value = 0.05, with a 0.574 of effect size and potential 10% loss of data, the required size for each group was estimated to be 30 participants [10,11]. Participants criteria included healthy males and females aged from 18 to 30 years old; body mass index (BMI) from 18.5 to under 23 kg/m2 having no problems with stress, anxiety, depression (according to the Depression, Anxiety and Stress Scale - 21 Items, DASS 21 scale); vital signs within normal limits: pulse 60 – 100 beats per minutes; blood pressure from 90/60 to less than 140/90 mmHg; body temperature 36.59 ± 0.43°C; and not currently participating in other intervention studies; For the present study, exclude those participants who had insomnia, common cold, thyroid diseases; inflammation of the neck skin; menstruation period, pregnancy, or breastfeeding; physical activity 2 hours before the study; use of alcohol, coffee, tobacco, sedatives or drugs that cause vasodilation and affect blood pressure and heart rate within 24 hours before enrolment; use of chemical or pharmaceutical products to the posterior neck; treatment with physical therapy, heat therapy, cupping, massage, acupuncture in the posterior neck within 24 hours.

Study procedure

Recruitment and explanation of procedures were carried out, with volunteers signing informed consent forms. Eligible subjects were assigned into two groups of 30 (Group A with acupuncture on left hand and Group B with acupuncture on right hand) in a 1:1 allocation ratio in a random order. Participants in each group received two sessions 07 days apart with the same acupuncture protocol but differing only in acupoint location. In each group, participants received acupuncture at LU-10 in the first session and at SI-3 in the second session. The participants have no knowledge of the location and effect of acupoints and were not informed of their exact acupuncture session sequences.

Acupuncture techniques

In this study, SI-3 acupoint is determined on the dorsum of the hand, proximal to the ulnar side of the fifth metacarpophalangeal joint, at the demarcation between the red and white flesh [2]. LU-10 acupoint is located on the palm, radially to the midpoint of the first metacarpal bone, also at the boundary between the red and white flesh [2]. Acupuncture was performed by a licensed medical doctor. Sterile disposable needles (15 mm in length and 0.30 mm in diameter, Khanh-Phong brand) were operated to a depth of 0.5 - 1 cun on acupoints, depending on the muscles thickness [9].

During every session, the participant sat comfortably on a chair and exposed hand, and skin surface temperature at the posterior neck. Acupuncture was performed by inserting and manipulating the needle for 60 seconds. Upon needle insertion, the practitioner rotated the handle of the needle clockwise and counterclockwise, evenly from 180° to 270°, repeating this action 60 to 120 times within 60 seconds to achieve the Deqi sensation. The needle remained in place for 10 minutes, with additional stimulation every 5 minutes, and was then removed. The stimulation method was identical for both acupoints and sessions.

Measurements for each acupuncture session

Skin surface temperature at the posterior neck was measured using infrared thermal camera (FLIR C5™, FLIR® Systems, Inc.) at five time points with 5-minute intervals (Figure 1): 5 minutes prior to acupuncture (T1), immediately after needle insertion (T2), 5 minutes post-insertion (T3), immediately before needle removal (T4), and 5 minutes after needle withdrawal (T5). Temperature survey area was the posterior region of the neck (between inferior borderline of head and line across the spinous process of the seventh cervical vertebra and the acromion). The camera was positioned 0.5 meters from the target area, oriented perpendicularly to the skin surface. To account for the effects of circadian rhythms, measurements were taken from 09:00 to 17:00. The room was kept quiet and the ambient temperature at approximately 25 ± 1°C.
and relative humidity approximately 50% to 60% without the presence of electrical equipment that generated heat and with no direct incidence of air or sunlight \cite{12,13}. Participants wore comfortable clothes and sat on high-backed chairs with their feet elevated. FLIR Thermal Studio software, version 1.9 (FLIR Systems), was used to determine the temperature value.

**FIGURE 1: Time points to measure skin surface temperature of the posterior neck**

Other baseline measurements were taken including pulse, blood pressure, body temperature by monitoring sheet. Adverse events, such as severe pain, bleeding, nausea, vomiting, and dizziness, were monitored throughout the study.

**Statistical Analysis**

All statistical analyses were performed using the Stata version 14.0 software (STATA Corp LP, College Station, TX, USA). A p-value of < 0.05 was considered significant. All tests were two-tailed. The continuous variables were expressed as the mean and standard deviation or median and interquartile range, whereas the categoric variables were expressed as numbers and percentages. Since the data measured in the present study are not normally distributed were used to compare treatment effects on groups at different times and Wilcoxon signed-rank test and Mann-Whitney test were used to evaluate differences between the groups.

**Results**

**General characteristics of the study population**

All 60 eligible volunteers, comprising 30 in each group (A and B), completed the study without any dropouts or exclusions. Table 1 showed the characteristics of the study population. There were no significant differences in gender, age, and BMI between group A and group B.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Group A - left hand (n = 30)</th>
<th>Group B - right hand (n = 30)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender, n (%)</td>
<td>Male 15 (50)</td>
<td>15 (50)</td>
<td>1*</td>
</tr>
<tr>
<td></td>
<td>Female 15 (50)</td>
<td>15 (50)</td>
<td></td>
</tr>
<tr>
<td>Age, years (Mean ± SD)</td>
<td>20.97 ± 2.03</td>
<td>20.3 ± 1.91</td>
<td>0.19#</td>
</tr>
<tr>
<td>BMI, kg/m² (Mean ± SD)</td>
<td>20.71 ± 1.59</td>
<td>20.42 ± 1.45</td>
<td>0.46#</td>
</tr>
</tbody>
</table>

**TABLE 1: Characteristics of the study sample at baseline (n = 60)**

*Tested using Chi-square test, #Tested using Independent Samples T-test

Abbreviation: SD, standard deviation, BMI, body mass index

The differences in pulse, blood pressure, and body temperature before acupuncture between the first and second trial session were not statistically significant. Besides, there were no statistically significant
differences in pulse, blood pressure, and body temperature before and after acupuncture in both group A and B. (Table 2 and 3).

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Acupuncture at left Yuji LU-10 acupoint (n = 15)</th>
<th>Acupuncture at left Houxi SI-3 acupoint (n = 15)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulse, bpm (Mean ± SD)</td>
<td>Before acupuncture</td>
<td>77.23 ± 8.24</td>
<td>78.33 ± 7.11</td>
</tr>
<tr>
<td></td>
<td>After acupuncture</td>
<td>76.53 ± 8.21</td>
<td>78.07 ± 7.08</td>
</tr>
<tr>
<td></td>
<td>p-value</td>
<td>0.17&lt;sup&gt;†&lt;/sup&gt;</td>
<td>0.62&lt;sup&gt;†&lt;/sup&gt;</td>
</tr>
<tr>
<td>Systolic blood pressure, mmHg (Mean ± SD)</td>
<td>Before acupuncture</td>
<td>106.27 ± 9.59</td>
<td>106.33 ± 9.35</td>
</tr>
<tr>
<td></td>
<td>After acupuncture</td>
<td>105.33 ± 9.71</td>
<td>105.57 ± 9.62</td>
</tr>
<tr>
<td></td>
<td>p-value</td>
<td>0.12&lt;sup&gt;†&lt;/sup&gt;</td>
<td>0.19&lt;sup&gt;†&lt;/sup&gt;</td>
</tr>
<tr>
<td>Diastolic blood pressure, mmHg (Mean ± SD)</td>
<td>Before acupuncture</td>
<td>68.8 ± 6.78</td>
<td>70.17 ± 6.16</td>
</tr>
<tr>
<td></td>
<td>After acupuncture</td>
<td>69.37 ± 6.63</td>
<td>70.47 ± 6.34</td>
</tr>
<tr>
<td></td>
<td>p-value</td>
<td>0.27&lt;sup&gt;†&lt;/sup&gt;</td>
<td>0.65&lt;sup&gt;†&lt;/sup&gt;</td>
</tr>
<tr>
<td>Body temperature, °C (Mean ± SD)</td>
<td>Before acupuncture</td>
<td>36.41 ± 0.16</td>
<td>36.47 ± 0.25</td>
</tr>
<tr>
<td></td>
<td>After acupuncture</td>
<td>36.44 ± 0.17</td>
<td>36.48 ± 0.2</td>
</tr>
<tr>
<td></td>
<td>p-value</td>
<td>0.23&lt;sup&gt;†&lt;/sup&gt;</td>
<td>0.86&lt;sup&gt;†&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

**TABLE 2: Characteristics of pulse, blood pressure, body temperature in group A (n=30)**

<sup>†</sup>Comparison between before and after acupuncture, Paired Samples T-test

<sup>‡</sup>Comparison between 2 trial sessions, Independent Samples T-test

Abbreviation: SD, standard deviation; bpm, beats per minute
<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Acupuncture at right Yuji LU-10 acupoint (n = 15)</th>
<th>Acupuncture at right SI-3 acupoint (n = 15)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pulse, bpm (Mean ± SD)</strong></td>
<td>Before acupuncture</td>
<td>After acupuncture</td>
<td>0.47#</td>
</tr>
<tr>
<td></td>
<td>75.9 ± 9.07</td>
<td>77.47 ± 7.54</td>
<td></td>
</tr>
<tr>
<td></td>
<td>After acupuncture</td>
<td>75.87 ± 9.12</td>
<td>0.46#</td>
</tr>
<tr>
<td>p-value</td>
<td>0.95*</td>
<td>0.96*</td>
<td>-</td>
</tr>
<tr>
<td><strong>Systolic blood pressure, mmHg (Mean ± SD)</strong></td>
<td>Before acupuncture</td>
<td>After acupuncture</td>
<td>0.81#</td>
</tr>
<tr>
<td></td>
<td>108.73 ± 10.5</td>
<td>106.87 ± 8.67</td>
<td></td>
</tr>
<tr>
<td></td>
<td>After acupuncture</td>
<td>107.87 ± 9.44</td>
<td></td>
</tr>
<tr>
<td>p-value</td>
<td>0.29*</td>
<td>0.55*</td>
<td>-</td>
</tr>
<tr>
<td><strong>Diastolic blood pressure, mmHg (Mean ± SD)</strong></td>
<td>Before acupuncture</td>
<td>After acupuncture</td>
<td>0.38#</td>
</tr>
<tr>
<td></td>
<td>70.83 ± 6.74</td>
<td>71.17 ± 7.49</td>
<td></td>
</tr>
<tr>
<td></td>
<td>After acupuncture</td>
<td>70.77 ± 7.39</td>
<td></td>
</tr>
<tr>
<td>p-value</td>
<td>0.97*</td>
<td>0.11*</td>
<td>-</td>
</tr>
<tr>
<td><strong>Body temperature, °C (Mean ± SD)</strong></td>
<td>Before acupuncture</td>
<td>After acupuncture</td>
<td>0.41#</td>
</tr>
<tr>
<td></td>
<td>36.43 ± 0.13</td>
<td>36.46 ± 0.17</td>
<td></td>
</tr>
<tr>
<td></td>
<td>After acupuncture</td>
<td>36.47 ± 0.16</td>
<td></td>
</tr>
<tr>
<td>p-value</td>
<td>0.19*</td>
<td>0.36*</td>
<td>-</td>
</tr>
</tbody>
</table>

**TABLE 3: Characteristics of pulse, blood pressure, body temperature in group B (n=30)**

*Comparison between before and after acupuncture, Paired Samples T-test

#Comparison between 2 trial sessions, Independent Samples T-test

Abbreviation: SD, standard deviation; bpm, beats per minute

**Temperature difference between time points**

When acupuncture at the left and right LU-10 acupoint, there was no difference in skin surface temperature in the posterior neck between the times of T2, T3, T4, T5 compared to T1. However, we observed statistically significant differences in skin surface temperature of the posterior neck at the time of T2, T3, T4, T5 compared to T1 (p < 0.05) when acupuncture at the left and right SI-3 acupoint. (Figure 2).
Temperature differences between acupuncture at LU-10 and SI-3

In group A, at baseline, there was no difference in skin surface temperature of the posterior neck before acupuncture between the two sessions. At the time after acupuncture of T2, T3, T4, T5, the median of skin surface temperature of the posterior neck was 35.4°C interquartile range (IQR) (34.7–35.8), 35.35°C IQR (34.9–35.7), 35.3°C IQR (34.7–35.7) at the left LU-10 acupoint and 35.75°C IQR (35.5–36.5), 35.75°C IQR (35.5–36.5), 35.75°C IQR (35.5–36.2) in participants with acupuncture at the left SI-3 acupoint. The difference in skin surface temperature of the neck at the post-insertion times between acupuncture at LU-10 and SI-3 were statistically significant. Compared with acupuncture at the left LU-10, participants with acupuncture at the left SI-3 acupoint had statistically significantly higher skin surface temperature of the posterior neck at the post-insertion times of T2, T3, T4, T5 (p < 0.01). (Figure 2).

In group B, at baseline, there was no difference in skin surface temperature of the posterior neck before acupuncture between the two sessions. At the time after acupuncture of T2, T3, T4, T5, the median of skin surface temperature of the posterior neck was 35.1°C interquartile range (IQR) (34.8–35.6), 35.5°C IQR (34.8–35.6), 35.2°C IQR (34.8–35.5), 35.1°C IQR (34.8–35.6) at the right LU-10 acupoint and 35.75°C IQR (35.4–36.1), 36.15°C IQR (35.5–36.4), 36.15°C IQR (35.4–36.4), 36.1°C IQR (35.1–36.5) in participants with acupuncture at the right SI-3 acupoint. The difference in skin surface temperature of the neck at the post-insertion times between acupuncture at LU-10 and SI-3 were statistically significant. Compared with acupuncture at the right LU-10, participants with acupuncture at the right SI-3 acupoint had statistically significantly higher skin surface temperature of the posterior neck at the post-insertion times of T2, T3, T4, T5 (p < 0.01). (Figure 3).
When acupuncture at SI-3 acupoint on the left hand and the right hand, the skin surface temperature of the posterior neck was not a statistically significantly different between the two groups. (Table 4).

<table>
<thead>
<tr>
<th>Times</th>
<th>Group A - left hand (n = 30)</th>
<th>Group B - right hand (n = 30)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature at T1, °C</td>
<td>35.3 (34.7–35.6)</td>
<td>35.2 (34.8–35.5)</td>
<td>0.69ab</td>
</tr>
<tr>
<td>Temperature at T2, °C</td>
<td>35.75 (35.3–36.3)</td>
<td>35.75 (35.4–36.1)</td>
<td>0.75ab</td>
</tr>
<tr>
<td>Temperature at T3, °C</td>
<td>35.8 (35.5–36.3)</td>
<td>36.15 (35.5–36.4)</td>
<td>0.56ab</td>
</tr>
<tr>
<td>Temperature at T4, °C</td>
<td>35.75 (35.5–36.5)</td>
<td>36.15 (35.4–36.4)</td>
<td>0.93ab</td>
</tr>
<tr>
<td>Temperature at T5, °C</td>
<td>35.75 (35.3–36.2)</td>
<td>36.1 (35.1–36.3)</td>
<td>0.68ab</td>
</tr>
</tbody>
</table>

**TABLE 4: Comparison of posterior neck temperature when acupuncture at the left and right Houxi (SI-3) acupoint**

a Mann-Whitney test

Abbreviation: IQR, interquartile range; T1, 5 minutes before acupuncture; T2, immediately after insertion; T3, after 5 minutes of insertion; T4, immediately before needle withdrawal and T5, 5 minutes after needle withdrawal.

**Adverse events**

There were 3 cases of bleeding after withdrawing the needle, the level of bleeding was not serious and was managed by pressing and holding sterile cotton swab at the insertion site for 30 seconds.

**Discussion**

The study’s primary finding revealed a significant increase in skin surface temperature at the posterior neck after acupuncture induced Deqi at both left and right SI-3 acupoints. However, under similar conditions, when acupuncture and stimulation were applied to the LU-10 acupoint, no change in skin temperature was observed. This outcome provides concrete evidence of the corresponding relationship between the SI-3 acupoint and the posterior neck area, confirmed by prior research on temperature changes in specific effect areas corresponding to acupoints [10,14,15].

Our hypothesis posits that the rise in skin surface temperature at the posterior neck is linked to enhanced
microcirculation beneath the skin in this region. In thermoregulatory physiology, roughly 60% of heat
dissipation occurs through infrared radiation in resting conditions, reliant on core body heat transfer via the
circulatory system to the skin's periphery, subsequently radiated as heat. This process is directly
proportional to subcutaneous blood flow. Studies by Tao Huang (2012) [16] and others have shown that
acupuncture at certain acupoints can elevate microcirculation at related acupoints. For example,
acupuncture at Quchi acupoint (LI-11) increased blood flow at Sanjiao (LI-3), Hegu (LI-4), and Yangxi (LI-5)
acupoints. Similar findings for the "six major acupoints" group corroborate the specificity of acupoints in
modifying blood flow within defined areas, as demonstrated in studies by Wang (2007) [17], and Tian (2011)
[6]. These collective outcomes further substantiate our hypothesis.

Prior studies have indicated an increase in nitric oxide (NO) synthesis within stimulated meridians and
acupoints at the biochemical level. In a study conducted by Tsuchiya [18], it was observed that acupuncture
led to enhanced blood flow and increased NO concentration in the treated limb, showing a positive
correlation. This suggests that the elevation in NO concentration contributes to heightened blood
circulation, subsequently increasing heat dissipation through skin radiation. However, further research is
necessary to substantiate this hypothesis.

Moreover, when acupuncture was applied to the SI-3 acupoint on either the right or left hand, there was an
equivalent increase in skin surface temperature on both sides of the posterior neck. This observation
provides initial insights into the bilateral SI-3 acupoints having a uniform effect on the posterior neck
region, aligning with traditional medicine theories about meridians and acupuncture points. In traditional
medicine, Stream (Shu) points are areas where the Qi of the channel flows and swirls, leading to a rapid and
substantial Qi flow, earning them the name “transporting” points. Furthermore, these points are where
Defensive Qi congregates. SI-3, functioning as the Stream (Shu) point of the Small-Intestine meridian,
experiences flourishing Qi in the meridian. Additionally, it serves as the opening point of the Governing
Vessel (Du Mai). As a result, acupuncture induced Deqi at the SI-3 acupoint promotes Qi movement, not only
in the Small-Intestine meridian but also within the Governing Vessel. The Governing Vessel, often referred
to as the ‘Sea of Yang channels’ influences all Yang channels, reinforcing the body’s Yang energy. According
to certain traditional medicine theories, skin surface temperature is regulated by Defensive Qi, implying that
eliciting a Deqi sensation through stimulation can modulate skin temperature accordingly [4].

Our study findings offer evidence supporting the selection of remote acupoints, distant from the affected
area, for treatment. Additionally, the uniform effect on posterior neck temperature by both left and right SI-
3 acupoints suggests that these acupoints share comparable therapeutic effects on the posterior neck. This
flexibility allows for the alternating use of either SI-3 acupoint in clinical treatment, tailored to the specific
patient’s condition.

Regarding safety, only three cases of bleeding following needle removal were observed in our study, and they
were minor with no further complications. This aligns with prior research, reinforcing the notion that
acupuncture is a relatively safe medical treatment with infrequent serious side effects. Most complications
are mild, such as pain, bleeding, or swelling, requiring no treatment [19].

These complications typically arise from factors like the patient’s mental stress, improper acupuncture
manipulation, or insufficient disinfection of the acupuncture area [20]. To mitigate these risks, we
conducted thorough assessments of participants’ medical history, vital signs, and allergy history. Our
acupuncturist, holding a medical doctor’s license and specialized training in acupuncture, rigorously
adhered to the prescribed technical procedures issued by the Ministry of Health, closely monitoring
participants during the procedure. These measures contributed to the low incidence of complications during
acupuncture.

According to Fernández-Cuevas [12], factors influencing infrared camera temperature survey images include
environmental, personal, and technical factors. Our study addressed personal factors by ensuring the
homogeneity of age, gender, and BMI between study groups. Both LU-10 and SI-5 acupoints were examined
on the same group, eliminating variations related to these personal factors.

Physiological parameters like pulse, blood pressure, and body temperature exhibited no statistically
significant differences between the first and second sessions, reinforcing the volunteers’ consistent
physiological states during the trials. Post-acupuncture measurements revealed no significant alterations in
pulse, blood pressure, or body temperature, confirming the safety of acupoint application in clinical
settings, particularly for patients with pre-existing cardiovascular conditions. The lack of significant
changes in body temperature before and after acupuncture in both study sessions reinforces the specificity
of any observed temperature changes in localized areas.

This pioneering study utilized infrared camera technology to investigate the corresponding relationship
between the SI-3 acupoint and the posterior neck. Distinguished by its comprehensiveness, this research
introduced a non-specific acupoint control group and employed single blinding to enhance result accuracy.
It adhered to rigorous standards for the research environment and participants, with explicit evaluation of
adverse events, thereby bolstering evidence of acupuncture safety for clinical applications.
While this study aimed to assess the association between the SI-3 acupoint and posterior neck skin surface temperature, the specific mechanisms underlying the temperature increase remain elusive. Further exploration and evaluation of acupoint effects using alternative methodologies is warranted. Additionally, due to the limitations of the infrared camera equipment, continuous monitoring of skin surface temperature fluctuations was not possible. Hence, we recommend conducting similar investigations with equipment capable of continuous temperature recording.

**Conclusions**

The study’s findings provided both objective evidence and therapeutic implications for the SI-3 acupoint’s effectiveness in treating the posterior neck area by examining the association between the SI-3 acupoint and posterior neck skin surface temperature. Furthermore, this research indicates that applying acupuncture on either the left or right SI-3 acupoints exhibited comparable therapeutic effects on posterior neck skin surface temperature. Besides, acupuncture at the Houxi acupoint is safe when applied clinically if specific acupuncture procedures are followed.

**Additional Information**

**Author Contributions**

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

**Concept and design:** Dieu-Thuong Thi Trinh, Chi-Thien Vo, Minh-Man Pham Bui

**Critical review of the manuscript for important intellectual content:** Dieu-Thuong Thi Trinh, Nguyen Lam Vuong

**Supervision:** Dieu-Thuong Thi Trinh, Minh-Man Pham Bui

**Acquisition, analysis, or interpretation of data:** Chi-Thien Vo, Nguyen Lam Vuong

**Drafting of the manuscript:** Chi-Thien Vo, Minh-Man Pham Bui

**Disclosures**

**Human subjects:** Consent was obtained or waived by all participants in this study. Institutional Review Board of the University of Medicine and Pharmacy at Ho Chi Minh City issued approval 679/HD3D-DHYD. This study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Institutional Review Board of the University of Medicine and Pharmacy at Ho Chi Minh City on 31 August 2022, with the registration number: 679/HD3D-DHYD. Informed consent was obtained from all subjects involved in the study. **Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: Payment/services info: All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

**References**

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