Is there a difference between the effects of one-point and three-point indirect moxibustion stimulation on skin temperature changes of the posterior trunk surface?

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Abstract

Objective To determine whether any difference exists in responses to indirect moxibustion relative to thermal stimulation sites.

Methods Twenty one healthy men of mean±SD age 22.5±6.1 years were randomly divided into two groups, one receiving a single moxibustion stimulation in three locations (the three-point stimulation group, n=10 participants) and the other receiving three stimulations in one location (the one-point stimulation group, n=11 participants). The thermal stimulation sites were GV14, GV9 and GV4 acupuncture points. A thermograph was used to obtain the skin temperature on the posterior trunks of the participants. To analyse skin temperature, four arbitrary frames (the scapular, interscapular, lumbar and vertebral regions) were made on the posterior trunk.

Result An increase in skin temperature on the posterior trunk was observed following both one- and three-point moxibustion administrations. The skin temperature of the lumbar region showed a significant increase after three-point stimulation compared with single-point stimulation (p=0.011). There was also a significant increase in skin temperature of the spinal region after three-point stimulation compared with one-point stimulation (p=0.046).

Conclusion Administration of single moxibustion doses on the GV14, GV9 and GV4 points produces greater changes in skin temperature than three applications of moxibustion to the GV14 point only.

INTRODUCTION

Moxibustion therapy has been used in tandem with acupuncture to treat and prevent various illnesses in eastern Asia since ancient times. Moxibustion is a form of thermal therapy that involves burning the herb moxa (Artemisia vulgaris, commonly called mugwort) over acupuncture points. Moxibustion has been applied using various procedures. One of the most commonly used forms of the treatment, indirect moxibustion (IM), involves the administration of thermal stimulation without direct contact between the burning moxa and the surface of the skin.

Thermal stimulation provides thermal energy to the skin surface and excites cutaneous mechanoreceptors. Adriaensen et al demonstrated that 44.5–46.5°C thermal stimulation applied on human skin activated A-fibre mechanohot nociceptors (AMH). A study by Fitzgerald and Lynn indicated that the administration of 50–55°C thermal stimulation to animals (cats, rabbits) activated high-threshold mechanoreceptors (HMH). Goto et al showed that 60–70°C thermal stimulation achieved by administering moxibustion to human skin activated C-fibre mechanohot nociceptors (CMH). These previous studies show that thermal stimulation >44.5°C elicits the excitation of receptors such as CMH and AMH.

With regard to the effects of thermal stimulation on neurovascular systems, Sato et al suggested that various somatosensory stimulations such as mechanical stimulation (electrical stimulation) and thermal stimulation increase muscle blood flow through the vasodilation response. A study by Golay et al further suggested that local thermal stimulation induces blockage of the muscarinic receptor and production of prostaglandins as the mechanism of vasodilation response. Noguchi et al reported the involvement of the sympathetic α receptor system as part of the mechanism for alterations of peripheral circulation by IM.

A few studies have been conducted to investigate the thermal properties of IM. A study by Chiba et al indicated that IM (Camaya Mini, mild heat type) resulted in maximum skin surface temperatures of 65°C and 45°C in the subcutaneous tissue of rats. However, using the same type of IM, Mori et al found that the resulting human skin temperature ranged from 46°C to 67.5°C (mean 50°C). A study by Yi investigated the thermal properties of a different type of IM in which moxa was placed on sliced garlic. The study showed that the maximum temperature when the moxa was applied on a 1.7 mm garlic slice reached 43°C at the first application, rising to 55°C during the fourth consecutive application. Based on the thermal properties noted in the previous studies, it can
be hypothesised that IM stimulation excites mechanoheat-sensitive nociceptors such as AMH and CMH.

The magnitude of the thermal energy produced during moxibustion, however, is greatly affected by temperature intensity and the size of the stimulation area, and also by the duration of heat application. We previously conducted a study to determine the possible difference in skin temperature responses between the single-stimulation (3 min in duration) and triple-stimulation (9 min in duration) approaches to IM administered on the same acupuncture point and concluded that there was no difference in the skin temperature response to moxibustion between single-stimulation and triple-stimulation IM. Our previous finding clarified the optimal duration of IM for maximising the therapeutic benefits and minimising the adverse events associated with moxibustion such as burns.11

In clinical practice, however, treatment rarely consists of the administration of moxibustion on a single point but, rather, it is administered on multiple therapeutically indicated acupuncture points. Thus, in the present study, we compared IM applied on one location and three locations with the same duration of stimulation time in order to investigate skin temperature responses following IM therapy.

METHODS

Subjects

The study participants consisted of 21 healthy men of mean±SD age 22.5±6.1 years recruited from students and staff members of the Tsukuba University of Technology. They were randomly divided into two groups according to the envelope allocation method: 10 participants of mean age 23.6±8.0 years were assigned to receive a single moxibustion stimulation in three locations (the three-point stimulation group) and 11 participants of mean age 21.5±3.9 years were assigned to receive three stimulations in one location (the one-point stimulation group). The randomisation procedure was conducted by an individual who was blind to the details of the study. All participants were informed of the purpose and nature of the experiments and written consent was obtained from each participant in compliance with the World Medical Association Declaration of Helsinki.

Interventions

The stimulation sites were GV14 (between the C7 and T1 spinous process), GV9 (between the Th7 and Th8 spinous processes) and GV4 (between the L2 and L3 spinous processes) acupuncture points (figure 1). The GV14 acupuncture point has been used for neck and shoulder pain conditions in clinical and research settings.12 GV9 and GV4 have been used for the treatment of vasomotor symptoms in postmenopausal women in a recent clinical trial.13

We consider the GV14, GV9 and GV4 points suitable for observing skin temperature responses on the posterior trunk via thermography. Thermal stimulation was applied using IM through the Kamaya Mini (Kamaya Moxa Co Ltd, Tokyo, Japan). The Kamaya Mini IM apparatus consists of a cylindrical paper pipe (9 mm in diameter and 12 mm in height) filled with moxa. An 8 mm cavity between the moxa and the surface of the skin permits the indirect administration of thermal stimulation (figure 2).

Two different IM procedures were used for comparison. For three-point IM stimulation, the Kamaya Mini moxa was first burned on the GV14 point for 3 min and then removed, the second moxa was immediately burned on the GV9 point for 3 min and then removed and, lastly, the third moxa was administered on the GV4 point for 3 min and then removed. For one-point IM stimulation the moxa was burned on the GV14 point for 3 min and then removed and the procedure was repeated twice more on exactly the same location.

For both three-point and one-point stimulation, Kamaya-Mini moxa was burned for 3 min and then immediately replaced by a new moxa stick; thus, virtually no
time elapsed between the applications of moxa. The total duration of IM was 9 min for both intervention groups. Moxibustion was administered by a licensed acupuncturist who was instructed to inhibit conversations during the procedures.

**Measurements**

The experiments were conducted between 09:00 and 16:00 h in a room temperature set at 25°C and 50% humidity. A thermograph (JTG-5310; JEOL Ltd, Tokyo, Japan) was used to obtain the skin temperature on the posterior trunk of the participants. The participants were asked to remove their clothing from their upper bodies, lie on a table in a prone position and then rest for 10 min. Thermographic images were then obtained at the following time periods: before and immediately after the administration of IM and at 5, 10, 15 and 20 min afterwards.

The following locations were marked in order to develop arbitrary frames: the spinous process of the Th1, Th3, Th7, Th11 and L4 points; the medial border of the scapular spines (bilateral); the inferior border of the scapulas (bilateral); and the posterior superior iliac spine (bilateral).

To analyse skin temperature, four arbitrary frames (the scapular, interscapular, lumbar and vertebral regions) were made on the posterior trunk and the average temperatures of these frames were then obtained (figure 1).

**Statistical analysis**

Serial changes in skin temperature between the one-point and three-point IM groups were analysed using mixed-model two-way analysis of variance (ANOVA) and linear analysis using Sidak’s multiple comparison test. Serial changes in skin temperature within the groups were analysed via the mixed-model one-way ANOVA and Bonferroni’s multiple comparison tests. The percent change in skin temperatures for each group was expressed as \( \frac{(Post - Pre)}{Pre} \times 100 \).

SPSS Advanced Model V. 15 was used as the statistical analysis software. In all tests the level of significance was set at \( p<0.05 \). Values presented are mean (SD).

**RESULTS**

No adverse events occurred in either group.

**Skin temperature changes in the scapular region**

Skin temperature responses before and after administration of moxibustion are summarised in figure 3A and table 1. In the three-point stimulation group the skin temperature increased from 33.59±0.21°C at baseline to 34.18±0.16°C 20 min after moxibustion administration (\( p=0.00 \)) while, in the one-point stimulation group, the skin temperature increased from 34.35±0.16°C at baseline to 34.84±0.17°C 20 min after moxibustion administration (\( p=0.00 \)). There was significant group interaction in skin temperature (\( p=0.02 \)); however, the exact areas of change were not revealed on post hoc analysis.

**Skin temperature changes in the interscapular region**

Skin temperature responses before and after application of moxibustion are summarised in figure 3B and table 1. In the three-point stimulation group the skin temperature increased from 33.73±0.21°C at baseline to 34.08±0.16°C 20 min after moxibustion administration (\( p=0.00 \)) while, in the one-point stimulation group, the skin temperature increased from 34.52±0.17°C at baseline to 34.78±0.18°C 20 min after moxibustion administration (\( p=0.00 \)). There was significant group interaction in skin temperature (\( p=0.006 \)); however, the exact areas of change were not revealed on post hoc analysis.

**Skin temperature changes in the lumbar region**

Skin temperature responses before and after application of moxibustion are summarised in figure 3C and table 1. In the three-point stimulation group the skin temperature increased from 33.47±0.21°C at baseline to 34.38±0.16°C 20 min after moxibustion administration (\( p=0.00 \)) while, in the one-point stimulation group, the skin temperature increased from 34.26±0.15°C at baseline to 34.79±0.12°C 20 min after moxibustion administration (\( p=0.00 \)). There was significant group interaction in skin temperature (\( p=0.00 \)). A post hoc analysis showed a significant increase in skin temperature after three-point stimulation compared with one-point stimulation (\( p=0.011 \)).

**Skin temperature changes in the spinal region**

Skin temperature responses before and after application of moxibustion are summarised in figure 3D and table 1. In the three-point stimulation group the skin temperature increased from 33.68±0.20°C at baseline to 34.28±0.16°C 20 min after moxibustion administration (\( p=0.00 \)) while, in the one-point stimulation group, the skin temperature increased from 34.46±0.16°C at baseline
to 34.36±0.16°C 20 min after moxibustion administration (p=0.00). There was significant group interaction in skin temperature (p=0.00). A post hoc analysis showed a significant increase in skin temperature after three-point stimulation compared with one-point stimulation (p=0.046).

**DISCUSSION**

In this study we observed an increase in skin temperature on the posterior trunk following both one- and three-point moxibustion administrations. The acupuncture points used for stimulation were GV14, GV9 and GV4. Traditionally, the GV14 point has been used for conditions such as fever and bronchial asthma, GV9 has been used for jaundice and GV4 has been used for low back pain and urogenital disorders.14 15 Administering thermal stimulation to acupuncture points by moxibustion has been considered to elicit therapeutic responses possibly via neurovascular reflexes16 17 and immunomodulation.18 We consider that the mechanism behind the observed increase in skin temperature in this study was similar to that observed in our previous

**Table 1** Skin temperature changes in the three-point stimulation group (three-point IM) and the one-point stimulation group (one-point IM)

<table>
<thead>
<tr>
<th>Region</th>
<th>Pre</th>
<th>Post 0</th>
<th>Post 5</th>
<th>Post 10</th>
<th>Post 15</th>
<th>Post 20</th>
</tr>
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<tr>
<td>Scapular</td>
<td>Three-point IM</td>
<td>33.59±0.21</td>
<td>33.92±0.19</td>
<td>34.08±0.19</td>
<td>34.14±0.18</td>
<td>34.15±0.17</td>
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<tr>
<td></td>
<td>One-point IM</td>
<td>34.35±0.16</td>
<td>34.75±0.17</td>
<td>34.76±0.17</td>
<td>34.75±0.17</td>
<td>34.80±0.17</td>
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<tr>
<td>Interscapular</td>
<td>Three-point IM</td>
<td>33.73±0.21</td>
<td>33.95±0.19</td>
<td>34.09±0.19</td>
<td>34.09±0.19</td>
<td>34.11±0.17</td>
</tr>
<tr>
<td></td>
<td>One-point IM</td>
<td>34.52±0.17</td>
<td>34.85±0.18</td>
<td>34.81±0.18</td>
<td>34.78±0.17</td>
<td>34.78±0.17</td>
</tr>
<tr>
<td>Lumbar</td>
<td>Three-point IM</td>
<td>33.47±0.21</td>
<td>33.92±0.19</td>
<td>34.16±0.17</td>
<td>34.24±0.18</td>
<td>34.34±0.17</td>
</tr>
<tr>
<td></td>
<td>One-point IM</td>
<td>34.26±0.15</td>
<td>34.73±0.16</td>
<td>34.68±0.13</td>
<td>34.69±0.13</td>
<td>34.74±0.14</td>
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<tr>
<td>Spinal</td>
<td>Three-point IM</td>
<td>33.68±0.20</td>
<td>34.06±0.18</td>
<td>34.21±0.18</td>
<td>34.24±0.17</td>
<td>34.28±0.16</td>
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<tr>
<td></td>
<td>One-point IM</td>
<td>34.46±0.16</td>
<td>34.85±0.16</td>
<td>34.82±0.17</td>
<td>34.82±0.16</td>
<td>34.85±0.16</td>
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</tbody>
</table>

Values presented are mean (SD) °C.
Pre, baseline; Post 0, immediately after IM; Post 5, Post 10, Post 15 and Post 20, 5, 10, 15 and 20 min after IM.
IM, indirect moxibustion.
study which attempted to determine the optimal duration of thermal stimulation.

Sato et al indicated that a response in neuroeffectors occurs through different mechanisms including central sensitisation, peripheral sensitisation and the axon reflex, and that these response mechanisms are evoked by mechani-cal, chemical or thermal stimulations. They also found, however, that skin nociceptors have high thresholds against mechanical, thermal or chemical stimulation, so it is hard to excite these receptors without activating low-threshold sensory receptors. The nociceptors of primates and humans are most responsive to thermal heat stimuli. Thermal stimulation is thought to activate simultaneously the Aδ fibres (III group) that insert in the epidermis and afferent fibres and the nociceptive C (IV group) afferent fibres without activating other sensory receptors.

It has previously been shown that thermal heat administered in the present study reached approximately 50°C, so the responses seen in this study probably occurred via the skin nociceptors. The excitation of skin nociceptors then influences the peripheral vessels of the skin, resulting in reactions such as an increase in blood flow and a rise in skin temperature.

Kawakita et al indicated that the axon reflex induced by somatosensory stimulation such as acupuncture or moxibustion is related to the activation of the polymodal receptor. Noguchi et al observed blood flow change in the hind limbs of rats following moxibustion stimulation. They showed that moxibustion stimulation resulted in a transient decrease of muscle blood flow which probably occurred via activation of the α adrenergic receptors. Subsequently, muscle blood flow significantly increased due to unspecified regulatory mechanisms. Their study did not evaluate skin blood flow. Although there are acupuncture studies that show similar changes between skin and muscle blood flow, the implications of their findings in relation to our study are limited.

Although we believe that the increase in skin temperature after IM observed in the present study was elicited by the excitation of the thermal nociceptors via the autonomic nervous system, the exact mechanism is unknown and it remains a subject for future research.

In our previous study we reported that an increase in the skin temperature of the posterior trunk was observed after the application of IM in either 3 min or 9 min increments. In this study we hypothesised that it would be more clinically applicable and effective when three acupuncture point locations were thermally stimulated rather than when the same duration of stimulation was applied on the same point. The changes in skin temperature observed following IM in this study suggest that multiple-point stimulation may produce a more profound impact on skin temperature than single-point stimulation.

In conclusion, administration of single moxibustion doses on the GV14, GV9 and GV4 points produced greater skin temperature changes than three applications of moxibustion to the GV14 point only.

**Summary points**

- Skin temperature does not continue to increase with repeated moxibustion at a single site.
- We showed here that skin temperature does increase with moxibustion at three sites.

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**Competing interests** None.

**Patient consent** Obtained.

**Ethics approval** Ethics approval was obtained from the Research Ethics Committee of the Tsukuba University of Technology.

**Provenance and peer review** Not commissioned; externally peer reviewed.

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