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# **The physiological effect of DE QI during acupuncture**

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## **Abstract**

**Objective:** The present study can further explore the role of skin blood flow in the physiological mechanism of acupuncture stimulation using Yanglao (SI6) acupoint.

**Design:** The SI6 was acupuncture, until the "De-Qi" sensation was achieved and measure the change of blood flow at Xiaohai(SI8) by means of laser Doppler flowmetry.

**Results:** Our result showed when acupuncture at SI6, the blood flow at was increased immediately. The blood flow began to rise 5 s and increased  $11.1 \pm 0.9$  PU. Once the arm was tied up, the blood flow at the SI8 point slowed down quickly, and although still with twirling needle insertion, the blood flow at the SI8 point would no longer accelerate as a result ( $0.7 \pm 0.2$  PU).

**Conclusions:** In the present study seem to shows the acupuncture can regulate the autonomic nervous system resulting in the sphincter of microvessel will relaxing and the tissue fluid flowing out, and the propagated sensation along the meridian is caused by this large amount of tissue fluid which flows along loosen body stalk. The interstitial fluid increases during the needling and blood capillary expanding which may be one of the mechanisms of acupuncture regulation .

**Keywords:** blood flow, acupuncture, meridians, laser Doppler flowmetry,

## INTRODUCTION

Acupuncture can increase general circulation and specific organ blood flow changes the treatment of diseases,<sup>1</sup> but the De-Qi effects of acupuncture still remain unclear at the level of the microcirculation.

Acupuncture is rooted in a traditional history that dates back at least 3000 years and has been widely used in the treatment of diseases. Research has demonstrated the physiological and neurobiological basis for many of the effects of acupuncture, which has made it more acceptable for many Western physicians. This past year has seen research using single-photon-emission computerised tomography and functional magnetic resonance imaging technology to examine the effect of body acupuncture on brain physiology.<sup>2</sup> Meridians have been described as networks of invisible channels throughout the body through which vital energy flows.<sup>3</sup>

The present study can further explore the role of skin blood flow in the De-Qi physiological mechanism of acupuncture stimulation using SI6 acupoint.

## METHOD

The study was performed in fifty eight healthy volunteers, 20 males and 38 females, aged 18 to 24 years. Our experimentation was done on the healthy upper limbs. The subjects sit down. The blood flow on SI8 and SI6 of right hand or a non-acupuncture point chosen freely near SI8 and SI6 were recorded at the same time.

A pair of stainless steel needles of 0.2 mm in diameter, 30 mm in long were inserted vertically into the SI6 point. Following gradual insertion of the needle to a desired (2-3 mm), the needle was moved up and down (sparrow-pecking needling), or twisted (twisting needling). These type of needling are practical for a successful induction of the De-Qi sensation. The needles were stimulated manually, every 2-10 minutes, each time until the De-Qi sensation was achieved (in acupuncture, De-Qi sensation is a special feeling described by the subject) That is, the subject experiences a sensation of soreness, numbness, heaviness or distension around the region of the needle acupuncture point, sometimes radiating along its meridian for a considerable distance away from the activated acupuncture point (PSM: propagated sensation along meridians).<sup>4</sup>

Skin blood flow was recorded with the use of a laser Doppler flowmeter (Periflux 4001 Master, Perimed Ltd).<sup>5</sup> The device contains a solid-state, low-power diode laser (1 mW at the probe tip, wavelength 780 nm) that delivers a laser light to a cutaneous surface of [almost equal to]1 mm at a depth of [almost equal to]1 mm through flexible, graded-index, fiberoptic light guides.

Skin temperature was assessed continuously, under resting conditions, using an electronic thermometer (78214C, Hewlett-Packard, Palo Alto, Calif) and a circular metal thermocouple (0.8 cm<sup>2</sup>).<sup>6</sup>

Results are given as the mean  $\pm$ SE in perfusion units for each point measured. Student's t-test and ANOVA were used to calculate differences between time points as indicated by results. Probabilities of  $\leq 0.05$  were considered statistically significant.

## RESULTS

### The blood flow of acupuncture point

In resting condition we detected the profile of blood flow. The SI8 has the markedly amplitude of SVD (the singular value decomposition).<sup>5</sup> SVD-based method utilizes the exponential shape of the frequency spectrum of difference of the high and low. The vasomotion and heartbeat are the main influences on SVD.<sup>5</sup> The amplitude of SVD on the SI8 are significantly large ( $4.3 \pm 0.7$  PU)( $p = 0.017$ ) than of the nonacupoint ( $1.1 \pm 0.2$  PU)(Figure 1A,B) and the SI6 are significantly large ( $2.2 \pm 0.3$  PU) ( $p=0.024$ ) than of the nonacupuncture ( $0.9 \pm 0.2$  PU)( Figure 1C,D).

### Effects of Acupuncture on the Changes of Blood Flow

Acupuncture stimulation of a SI6 point sudden raised the blood flow in SI8 (Figure 2A), whereas nonacupuncture point beside the SI8 slightly changed the blood flow by the same acupuncture stimulation (Figure 2B). Figure 2A shows a typical example of augmentative effect of acupuncture on the change in blood flow. The SI8 blood flow was shown to be about  $9.8 \pm 3.1$  PU before the acupuncture stimulation. The data was acquired from the average of base line. The SI6 stimulation was given for about 15 s, until the "De-Qi" sensation was achieved. The blood flow was increased immediately after the "De-Qi" sensation. The blood flow began to rise after the onset of the "De-Qi" sensation being achieved and significantly increased  $11.1 \pm 0.9$  PU( $p=0.0009$ ) within 10 s(Figure 2C). The data was acquired from the difference between the maximum of peak and the base line. After acupuncture, the SI8 did not show continuous elevation of blood flow as SI6 (Figure 2A and 3). When the SI6 was stimulated until the "De-Qi" sensation was achieved, the blood flow of SI6 was continued increase ( $54.1 \pm 3.8$ ) (Figure 3) whereas nonacupuncture point beside the SI6 slightly changed the blood flow by the same acupuncture stimulation( $0.9 \pm 0.1$  PU) (Figure 3).

When the SI6 was stimulated repeatedly by acupuncture, the blood flow was increased again after the De-Qi sensation, even without subsequent needle twirling, and as long as the test person is getting the emergence of a strong De-Qi feeling (feeling numb, sore and hot sensations in his hands) or feeling a flow of numbness

and heat traveling to reach SI8, there will be a visible peak of upward SI8 blood flow (Figure 4).

Effect of mechanical force applied on the skin up the meridian

In order to find out that whether the PSM (propagated sensation along meridians) caused by acupuncture action is derived from the flow of tissue fluid along meridian channels, we tied up the upper arm of the test person with a length of rubber tubing (at a location 5 cm above the SI8 point). The result of the above test shows that before having the arm tied up with the rubber tubing, the acupuncture (SI6) derived De-Qi feeling (soreness and numbness) would bring about an acceleration of blood flow at the SI8 point ( $11.1 \pm 0.5$  PU) (Figure 5). Once the arm was tied up, the blood flow at the SI8 point slowed down quickly, and although it was still possible to get that somewhat sore De-Qi feeling with twirling needle insertion, the blood flow at the SI8 point would no longer accelerate as a result ( $0.7 \pm 0.2$  PU) (Figure 5), nor the appearance of PSM feeling afterward. It proves that obstruction of blood flow can effectively prevent PSM phenomenon from happening, and thus indicates the acupuncture derived PSM is very likely a phenomenon of a flowing sensation created by the motion of a large amount of tissue fluid entering meridian.

Effects of Acupuncture on the Changes of skin temperature

When the SI6 was stimulated by acupuncture, the skin temperature of palm was significantly increased  $0.71 \pm 0.20$  °C than of the control ( $0.18 \pm 0.09$  °C) (Figure 6). The data was acquired from the difference between the maximum temperature taken before and after acupuncture. There was an initial phase of increase in skin temperature of palm in resting, followed by secondary phase of rapidly increase in skin temperature of palm after acupuncture.

## DISCUSSION

In this study, intradermal stimulation by acupuncture caused a significant increase in blood flow. This may suggest that intradermal stimulation by acupuncture played a significant role in autonomic nervous system. Press needle applied to the posterior region of the upper arm is reported to facilitate the recovery from reduced twitch height of the biceps brachii after isometric contraction exercise, supporting the significant role of intradermal stimulation.<sup>7</sup>

When we acupuncture in SI6, the test person would immediately feel the sore and numb De-Qi sensation. This kind of De-Qi sensation happening right after the insertion of needle would cause an acceleration of blood flow at the SI8 point. A few minutes thereafter, if we twirl the needle (must have De-Qi feeling), the action will cause the same acceleration again. If we don't twirl the needle, but if the test person

gets a feeling of soreness, numbness and heat sensation within a few minutes after the insertion of needle, the same kind of blood flow acceleration would happen as well. Acupuncture points have both afferent and efferent nervous impulses. The present study showed that acupuncture increases skin temperature, suggesting that the increases of skin temperature resulted from cutaneous vasodilation due to acupuncture induced parasympathetic stress response. This suggestion is supported by previous studies that central command is generated by a potent stimulus and it plays an important role in cutaneous parasympathetic vasodilation.<sup>8</sup> Our results suggest that the autonomic nervous system participates in acupuncture stimulation.<sup>9</sup> Hsieh performed a positron emission tomography study, using regional cerebral blood flow as the index of brain activity, to address the specificity of brain activation pattern by acupuncture stimulation of acupoint.<sup>10</sup> Regions activated by acupuncture stimulation at SI6 included the hypothalamus with an extension to midbrain, the insula, the anterior cingulate cortex, and the cerebellum. Of note, it was only the stimulation at SI6 that activated the hypothalamus under the similar psychophysical ratings of acupuncture sensation (De-Qi).<sup>10</sup> The data suggested that the hypothalamus might characterize the central expression of acupuncture stimulation at the SI6, and serve as one key element in mediating efficacy of acupuncture stimulation.<sup>10</sup> Considering the fact that the afferent and efferent sympathetic C-fibres are involved in regulation of microcirculation, the skin blood flow regulation is investigated.<sup>11</sup> Hypothalamus can regulate the autonomic nervous system.<sup>12</sup> The skin blood flow is control by autonomic nervous system.<sup>13</sup> The perivascular nerves and vascular endothelial cells which regulate blood flow. Recent positron emission tomography studies have demonstrated areas of pain processing in the thalamus.<sup>14</sup> Blood flow and temperature are also regulatory in the thalamus. Stimulation of human thalamus for pain of acupuncture may change the skin blood flow and temperature.<sup>8,15</sup>

According to one model, the meridian is an extravascular fluid (interstitial fluid) pathway driven by skeletal muscle contraction.<sup>16</sup> In the present study seem to show the acupuncture can regulate the autonomic nervous system resulting in the sphincter of microvessel relaxing and the tissue fluid flowing out, and the propagated sensation along the meridian is caused by this large amount of tissue fluid which flows along loosen body stalk. The interstitial fluid increases during the needling and blood capillary expanding which may be one of the mechanisms of acupuncture regulation.<sup>17</sup>

Our result showed SI8 and SI6 have the larger amplitude of heartbeat and vasomotion than of the nonacupuncture point by means of laser Doppler flowmetry. The acupoints have a higher temperature.<sup>18</sup> The formation high thermal acupoints may have some relationship with the compact microcirculation. Lazorthes (1990)<sup>19</sup> has presented several models to account for the electrical properties of acupoints based on

charge movements and selective permeability of ions through different layers of the skin. The meridian in Chinese traditional medical science is in fact a pipeline of tissue fluid circulation. PSM is an obvious characteristic of meridian research. PSM could be produced by needle puncturing,<sup>20</sup> electric-acupuncture,<sup>21</sup> electric-stimulating or padding on the skin surface.<sup>22</sup> The phenomenon of PSM is the feeling of liquid flowing in a certain path on the skin. Recent studies indicate that it can be detected that radioactive element flows in the path after injection of a radiotracer (e.g.,  $\text{Na}_2\text{HP}^{32}\text{O}_4$ ,  $\text{NaI}^{125}$  and  $\text{NaTc}^{99}\text{O}_4$ ) at acupuncture points of humans and animals, it was found that the appearance of radiotracer paths can be visualized in the corresponding meridian lines, indirectly proving the existence of meridian lines in the human body and animals.<sup>19</sup> The fact that RBC with HRP tag injected at one point of the meridian could be found at another point of the meridian showed that the meridian could carry physical materials to flow along a specific path.<sup>23</sup> When the acupuncture on the SI6 acupuncture, the test person would immediately feel the sore and numb De-Qi sensation. This kind of De-Qi sensation happening right after the insertion of needle would cause an acceleration of blood flow at the SI8 point. It is the most remarkable that the heat sensation in particular will certainly cause the acceleration of blood flow. This hot, numb feeling developed within a few minutes after acupuncture, or the propagated sensation along the meridian, is most likely caused by the circulation of tissue fluid inside meridian such as acupuncture stimulating the flow of Qi along the meridian system.

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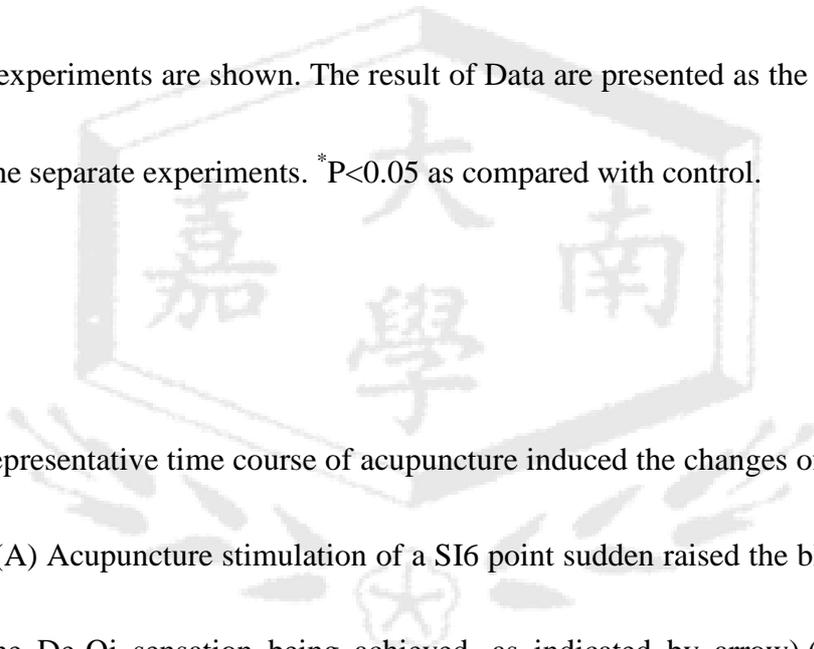
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## LEGENDS to FIGURES

**Fig. 1** Laser Doppler flow values (under resting conditions) measured in the skin of SI8 and nonacupoint. (A) Record illustrates the typical large-amplitude of heartbeat on the SI8 under resting conditions. (B) Control, nonacupoint beside the SI8. (C) Record illustrates the typical large-amplitude of heartbeat on the SI6 under resting conditions. (D) Control, nonacupoint beside the SI6. A representative curve of forty-nine experiments are shown. The result of Data are presented as the mean  $\pm$ S.E. of forty-nine separate experiments. \* $P < 0.05$  as compared with control.

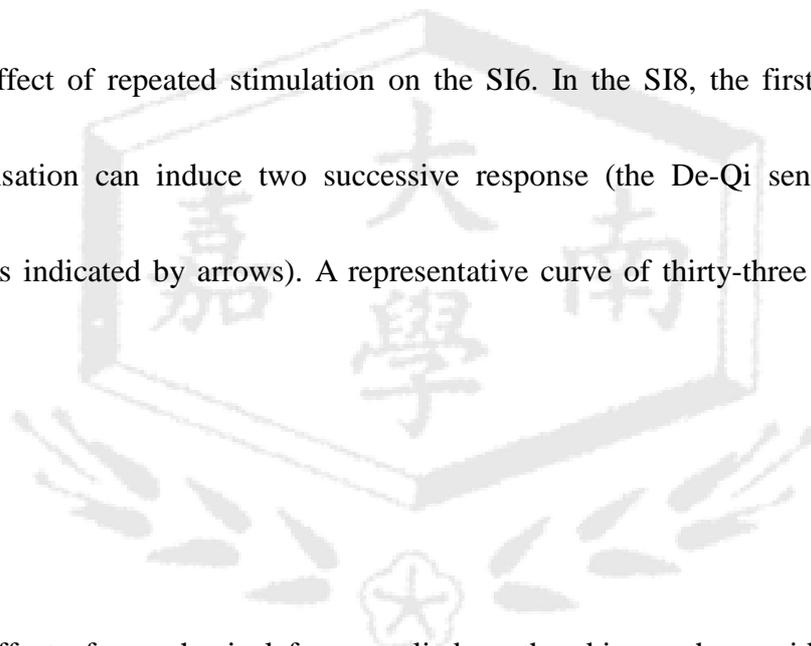


**Fig. 2** Representative time course of acupuncture induced the changes of blood flow in the SI8. (A) Acupuncture stimulation of a SI6 point sudden raised the blood flow in the SI8 (the De-Qi sensation being achieved, as indicated by arrow). (B) Control, nonacupoint beside the SI8. The result of Data are presented as the mean  $\pm$  S.E. of forty-one separate experiments. \* $P < 0.01$  as compared with control.

**Fig. 3** Effects of acupuncture on the changes of blood flow. When the SI6 was stimulated until the "De-Qi" sensation was achieved, the blood flow of SI6 was

continued increase (the De-Qi sensation being achieved, as indicated by arrow). A representative curve of twenty-six experiments are shown. The result of Data are presented as the mean  $\pm$ S.E. of twenty-six separate experiments. \*P<0.01 as compared with control.

**Fig. 4** Effect of repeated stimulation on the SI6. In the SI8, the first and second De-Qi sensation can induce two successive response (the De-Qi sensation being achieved, as indicated by arrows). A representative curve of thirty-three experiments are shown.



**Fig. 5** Effect of mechanical force applied on the skin up the meridian. Before having the arm tied up with the rubber tubing, the acupuncture (SI6) derived De-Qi feeling would bring about an acceleration of blood flow at the SI8 point (as indicated by arrows one). Once the arm was tied up, the blood flow at the SI8 point slowed down quickly and would not increase blood flow even twirling needle insertion (indicated by arrows two). The result of Data are presented as the mean  $\pm$ S.E. of forty-seven separate experiments. \*P<0.01 as compared with control.

**Fig. 6** Effects of Acupuncture on the Changes of skin temperature. When the SI6 was stimulated by acupuncture (indicated by arrow), the skin temperature of palm was increased. A representative curve of forty-five experiments are shown.

