Violet Laser Acupuncture—Part 2: Effects on Peripheral Microcirculation

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Abstract
Laser Doppler flowmetry for microcirculation monitoring was performed in 10 healthy volunteers (mean age±SD: 24.9±3.3 years; 5 females, 5 males) prior to, during, and after stimulation using a noninvasive violet (405 nm) laser needle at the Dazhui (GV14) acupoint. The results of this controlled study (control point at the shoulder) showed significant (p<0.05) increases in Flux (product of concentration and velocity of erythrocytes) at a distance of 3 cm from the acupoint. At the same time, no changes were found at the control point. Furthermore, 5 minutes after stimulation the microcirculation still flowed at a higher level than baseline values at the beginning of the investigation. In a single individual it was demonstrated that needle acupuncture enhanced this effect and placebo (deactivated laser) did not have a significant effect. The results suggest that violet laser acupuncture at the acupoint Dazhui can increase vascular effects on microcirculation.

1. Introduction
Recently the first scientific results concerning a new method of acupuncture, violet laser needle acupuncture, were presented within a cooperative research project between Asia and Austria [1–4]. In the first part of the study, reproducible effects on brain circulation were presented in the Journal of Acupuncture and Meridian Studies [1].

The goal of the second part in the series of studies was to investigate effects on peripheral microcirculation on the same volunteers. Again, measurements with deactivated laser (placebo) and a metal needle served as control.

2. Materials and Methods

2.1. Violet laser acupuncture
The method of laser needle acupuncture has been described in detail in the first part of this study [1] and in previous works [2–7]. The noninvasive violet optical needles (wavelength 405 nm, output power 110 mW, laser needle spot diameter 500 μm, time 10 minutes) were fixed onto the skin but not inserted into the skin. Measurements were performed using a research system from Laserneedle EG GmbH (Wehrden, Germany; Figure 1). This laser system consisted of 10 semiconductor injection...
laser diodes. Each single needle can emit a different wavelength. The technical parameters mentioned above are those given by the manufacturer. In the present study, a continuous wave mode (CW) was used. Due to coupling losses, the output at the tip of the laser needle was approximately 100 mW. Irradiation lasted 10 minutes (600 seconds) and therefore optical power energy density was very high (range: kJ/cm²).

2.2. Monitoring of microcirculation using laser Doppler flowmetry

Continuous microcirculation monitoring using laser Doppler flowmetry is an easy-to-use noninvasive real-time measurement method of local tissue blood flow. Using this type of biomedical equipment it is possible to quantify and objectify changes in microcirculation during different methods of laser stimulation [8]. A laser Doppler monitor DRT4 (Moor Instruments, Millwey, Axminster, UK) was used to determine Flux. Probe output was defined with 1 mW. Edge frequencies were 20 Hz and 22.5 kHz. Flux, which is the product of concentration and velocity of erythrocytes, was recorded at a distance of 3 cm distal from the acupoint (Flux 1) and at a control point proximal at the upper arm (Flux 2). The exact position of this control point was 2 cun above LI14 and 1 cun medially from the line connecting LI14 and LI15. This control point was chosen because no application of pressure occurs in this location, and the region of interest for the thermographic measurements (the back around the stimulation area) is not influenced by the sensor’s temperature.

2.3. Volunteers and procedure

The same 10 healthy volunteers (mean age±SD: 24.9±3.3 years; range 20–31 years; 5 females, 5 males; mean height±SD: 173.4±9.7 cm; mean weight±SD: 68.3±16.3 kg) as investigated in part 1 of the study [1] were evaluated. None of the volunteers were taking any medication. All persons were informed about the nature of the investigation as far as the study design allowed. The study was approved by the local ethics committee, and all volunteers gave written informed consent.

The persons were lying face down on a bed in our lab (constant room temperature 25ºC), the face in a sponge rubber mask similar to those used for the positioning of patients undergoing neurosurgery so that respiration was unhindered (Figure 2; see also part 1 of the publication [1]).

Four 5-minute periods of averaged data before (a), during (b, c), and after (d) violet laser stimulation were compared (Figure 2, top right). Therefore, irradiation lasted for 10 minutes.

Similar to the study design used in part 1 [1], all persons received active laser stimulation (n=10, see also Figure 3 in the results section). In addition, 2 of the 10 participants (randomly chosen) were investigated using needle and placebo (deactivated laser) stimulation for control purposes.

Acupuncture stimulation was performed at the Dazhui (GV14) point, located below the spinal process of the 7th cervical vertebra [1]. As mentioned in part 1 of the study, this is an important point for treating the common cold, occipital headache, cervical spondylosis, and torticollis. This point is also commonly used for moxibustion, and therefore suitable for violet laser stimulation, which to some extent also produces heat effects (this will be described in part 3 of the study).

Heart rate (medilog AR12, Huntleigh Healthcare, Cardiff, UK) and blood pressure (Cardiocap, Datex, Hoevelaken, Netherlands) were recorded in addition to microcirculation parameters.

2.4. Statistical analysis

Data were analyzed using Friedman repeated measures analysis of variance on ranks (SigmaPlot 11.0; Systat Software Inc., Chicago, USA) and Tukey’s test was used for post hoc analysis. The level of significance was defined as \( p<0.05 \).

3. Results

The new violet laser can trigger a de qi feeling, usually typical for needle acupuncture, which often manifests itself as a mild electric tingling.
Figure 2  Measurement procedure and application of the violet laser at the Dazhui acupoint and of the sensors for recording microcirculation. Top right: Measurement profile; the measurement phases are indicated with a (before), b, c (during) and d (after) 10 minutes of violet laser acupuncture. With permission of the volunteer and the co-author (TH).

Figure 3  Box plot illustration of changes of Fluxes (product of concentration and velocity of erythrocytes; in arbitrary units [a.u.]) at both measurement locations (Flux 1: Dazhui area; Flux 2: control area). Note the significant increase in Flux1 during (b, c; see Figure 2) stimulation (3 cm beside the Dazhui acupoint). The ends of the boxes define the 25th and 75th percentiles, with a line at the median and error bars defining the 10th and 90th percentiles. NS=not significant.

All 10 volunteers reported and immediately felt stimulus, similar to de qi feeling evoked by a metal needle. “The effect is comparatively not as strong as an ant bite, but longer lasting,” said a Chinese female volunteer.

Figure 3 summarizes the results of the 10 healthy volunteers. The microcirculation parameter Flux 1 changed significantly (p<0.05). Insignificant changes were found at the control point (Flux 2).

Stimulation using needle acupuncture enhanced the effect (see Figure 4), whereas the placebo procedure did not lead to any significant change.

Stimulation with violet laser at Dazhui resulted in insignificant changes in standard monitoring parameters like heart rate (a: 68.2±10.2; b: 68.1±9.7; c: 68.0±9.4; d: 68.1±9.9 [beats/minute]) or mean arterial blood pressure (before: 82.2±10.3; after: 82.5±7.3 [mmHg]).

4. Discussion

In 1996, Shuji Nakamura et al [9] reported the first electrically pumped blue laser. Scientists agree that the 21st century will be the century of photons, as the past 20th century was that of the electrons. Violet laser acupuncture using a non-invasive laser needle is characteristic for modernization of acupuncture [2]. Violet laser acupuncture started first at the TCM Research Center Graz, where several preliminary scientific studies have been performed [1–4]. The present controlled study has investigated the systemic effects of this new laser technology in respect to microcirculatory changes near an acupoint (Dazhui) and a control point.

The study of blood flow velocity in larger vessels is a well-known application of the Doppler principle using ultrasound waves. This has been reported in detail in part 1 of the present study [1]. Laser Doppler techniques have been used in medical research and practice for several decades. Disciplines like surgery, obstetrics, ophthalmology, anesthesiology, and intensive care medicine have experienced
many advantages from these innovative laser techniques [10]. This includes the evaluation of skin perfusion and microvascular dynamics in peripheral arterial occlusive disease, venous hypertension, Raynaud’s phenomenon, and diabetes as well as the assessment of pharmacological effects in various tissues. The laser Doppler technique offers also valuable aid in monitoring effects of acupuncture [8].

A number of studies investigating microcirculation in connection with acupuncture have been published (108 papers are currently available on the scientific database Pubmed). In fact, our research group published a review article on this topic in 2006 [8]. However, there are only a few publications available concerning stimulation of the acupuncture point Dazhui (GV14) and microcirculation monitoring. By contrast, other systemic effects of Dazhui are well documented. For example, Focks [11] introduces in her book the following three scientific papers. Li et al [12] performed a 3-hour prospective, randomized, controlled experiment in 40 Chinese healthy volunteers during simulated driving. Magnitopuncture was applied at Dazhui and Neiguan (PC6), and the main outcome parameter was heart rate variability. The test group that received verum acupuncture showed significantly reduced sympathetic and significantly increased parasympathetic activity [12]. A study by Hu [13] was found that, in addition to auricular pressing, cupping on Dazhui and three points on the bladder meridian yielded a curative effect in cases of hormone dependent bronchial asthma which enabled the patients to reduce the use of cortisone.

Tang et al [14] studied the effects of applying 10% Cantharides extract on Dazhui and Neiguan in 50 cases of perennial allergic rhinitis. The results showed that its effectiveness rate was 88%, with the allergic nasal mucosa provocative test of the treated group being significantly alleviated after the treatment.

The results of the present study show that acupuncture can lead to alterations in microcirculation parameters as found in previous investigations [15,16]. However, there are some limitations in our study design. A further controlled study stimulating a non-acupuncture point with the same technical equipment and recording tissue perfusion also a distance of 3 cm from this point should be conducted. A larger sample group may be required, but even despite the small number of subjects (n=10) it is interesting that there are significant results at the acupoint and distinct differences between violet laser stimulation, manual needle stimulation, and deactivated laser stimulation (placebo).

As the energy level of the violet laser stimulation was relatively high (range: kJ/cm²), tissue heating was induced. This phenomenon has already been described in a previous publication [2], where it was demonstrated using thermography that within 1 mm of the tip of the violet laser needle, a tissue temperature increase of 2.6°C was observed [2]. This temperature change in superficial tissue is of great importance. Further analyses concerning the temperature distributions in the region of interest (acupoint Dazhui) are in progress and will be described in the third part of this series of studies.
5. Conclusion

The microcirculation changes immediately and significantly after violet laser acupuncture at the acupoint Dazhui (distance 3 cm). At a control point, no significant alterations in Flux were observed.

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