

Yellow laser acupuncture – A new option for prevention and early intervention of lifestyle-related diseases: A randomized, placebo-controlled trial in volunteers

Daniela Litscher¹, Guangjun Wang^{1,2}, Ingrid Gaischek¹, Lu Wang¹,
Sandra Wallner-Liebmann³, Erwin Petek⁴

*1: Research Unit for Complementary and Integrative Laser Medicine,
and TCM Research Center Graz, Medical University of Graz, Graz, Austria*

*2: Institute of Acupuncture and Moxibustion, China Academy of Chinese Medical Sciences,
16 Nanxiaojie, Dongzhimennei, Beijing 100700, China*

3: Institute of Pathophysiology and Immunology, Medical University of Graz, Graz, Austria

4: Institute of Human Genetics, Medical University of Graz, Graz, Austria

Background and aims: The yellow laser constitutes a totally new option in the field of laser acupuncture, in addition to the already existing red, near infrared, green and violet lasers. Especially for so called lifestyle-related diseases, this could open up new methods of integrative therapy. The goal of the present study was to investigate among other parameters blood pressure (BP), heart rate (HR), heart rate variability (HRV), and temperature effects before, during, and after stimulation of different acupoints with yellow laser.

Subjects and methods: We recruited 26 healthy volunteers (13 female, 13 male; mean age \pm SD 24.1 \pm 3.3 years) at the Medical University of Graz. The acupoints Baihui, Neiguan, Taichong and a placebo point were stimulated with a 589 nm (50 mW, 500 μ m; 5 min) yellow laser. Blood pressure was measured noninvasively at the wrist; for the registration of the electrocardiogram a medilog AR12 HRV system was used. Effects on temperature were measured with a Flir i7 infrared camera.

Results: There were significant decreases after yellow laser acupuncture in the systolic BP, diastolic BP also decreased (n.s.). HRV in both (men and women) increased. The temperature during the yellow laser stimulation decreased significantly in all measured points. After the stimulation it increased again significantly. Based on a questionnaire volunteers reported a significantly decreased level of stress after yellow laser stimulation.

Conclusion: Significant positive effects on BP and well-being were found after yellow laser stimulation. The results are very promising and can be very important especially for the treatment of lifestyle related diseases.

Key words: Laser medicine · yellow laser · blood pressure (BP) · heart rate variability (HRV) · heart rate (HR) · temperature · laser acupuncture

Introduction

In many areas, laser is nowadays a very important instrument. It has become almost irreplaceable in data storage, laser printers, signal processing and amplifica-

tion in optical fiber networks, biomaterial processing or medical measurement technology. The city of Graz in Austria, Europe, is a very special place when lasers are concerned. The oldest still existing, functional laser of Austria was built almost exactly 50 years ago by Franz Aussenegg, who at that time was a young, dynamic physicist and developed this laser together with a Swiss company. At first, the ruby laser was used in research for five years in Graz. Afterwards the laser was used in student trainings (**Fig. 1**).¹⁾

Addressee for Correspondence:

Daniela LITSCHER, MSc
Research Unit for Complementary and Integrative Laser
Medicine and TCM Research Center Graz Medical University
of Graz Auenbruggerplatz 29 8036 Graz Austria
Phone: +43 316 385-13907
Fax: +43 316 385-13908
Email: daniela.litscher@medunigraz.at

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After several years of research and development, the first yellow laser for medical purposes was constructed in Germany in 2014. This system is available for non-invasive and/or interstitial acupuncture treatment at the Medical University of Graz, where it is being used for evidence-based medical research at the Research Center for Traditional Chinese Medicine (**Fig. 2**).²⁾ Yellow laser constitutes a new option in the field of laser acupuncture, in addition to the already existing red, near infrared, green and violet lasers. First evidence suggests that the yellow laser may be able to stimulate the mitochondrial respiratory chain at complex III (cytochrome).³⁾

The goal of the present study was to investigate for the first time blood pressure (BP), heart rate (HR), heart rate variability (HRV), and temperature effects before, during, and after stimulation of different acupoints with yellow laser. It should be mentioned explicitly that this is the first acupuncture study worldwide using yellow laser acupuncture.

Subjects and methods

Subjects

We investigated 26 volunteers (13 female, 13 male) with a mean age \pm SD of 24.1 ± 3.3 years, range 20 – 36 years, a height of 175.6 ± 10.6 cm, and a weight of 68.0 ± 10.0 kg at the Medical University of Graz. The 13 female volunteers had a mean age \pm SD of 23.8 ± 1.7 years (range 21 – 28 years), and the 13 male subjects had a mean age of 24.4 ± 4.4 years (range 20 – 36 years), so women and men were age-matched. None of the volunteers had a history of heart or cerebrovascular disease or was under the influence of centrally active medication, and all gave written informed consent. The investigations were approved by the local Ethics Committee and carried out in compliance with the Declaration of Helsinki.

Yellow laser stimulation and acupoints

The yellow laser used for the investigations works with a wavelength of 589 nm and an output power of 50 mW, and the fiber diameter is 500 μ m. A modified Weberneedle Endolaser system (Weber Medical, Lauenförde, Germany) was used. From the technical point of view, it is not easy to produce yellow laser light. Usually, a laser consists of an infrared laser diode and a so-called combo crystal. This pair of crystals produces the visible laser light. In this process, the combo crystal receives the necessary energy from the infrared diode. For a green laser, one crystal produces laser

light of 1064 nm and the other one doubles the frequency, which means that the wavelength is divided in half, resulting in 532 nm, i.e. green light. For yellow laser light to be produced, 1340 nm are necessary. If these were simply frequency-doubled, the emitted laser light would be red, but if red and green light is mixed, the result is yellow light. It is, however, a disadvantage that at 1340 nm only very little light is emitted, so the infrared diode needs to have a large power. Moreover, special filters have to be used in order for the correct ratio of 1064 and 1340 nm to permeate. This makes the production expensive and complex, which is why yellow lasers are very expensive and accordingly rare.¹⁾

Using a worldwide new, highly focussed yellow laser system (589 nm, 50 mW, 500 μ m) we investigated acute effects of laser stimulation at the acupoints Baihui (GV20), Neiguan (PC6), and Taichong (LR3; see **Fig. 3a-c**) on blood pressure (BP) and heart rate variability (HRV) within a controlled, experimental, randomized biomedical human volunteer study.

Baihui is located at electroencephalographic (EEG) electrode position Cz, on the continuation of the line connecting the lowest and highest points of the ear, on the median line of the head, and it is thought to be a very effective point, with a general sedative and harmonizing effect.^{4,5)} Neiguan is located at the wrist, between the tendons of m. palmaris longus and m. flexor carpi radialis, 2 cun proximal to the transverse crease of the wrist, and it is a very important point in disorders of the upper abdomen and for heart disorders.^{4,5)} Taichong is located on the dorsum of the foot, between the first and second metatarsal bones, 2 cun proximal to the margin of the web; it should be a very important point in the treatment of hypertension.^{4,5)}

All volunteers also received active laser stimulation at a placebo point (located lateral from the radius, 6 cun above the horizontal fold of the wrist exactly on the radial ledge, lateral from the pulmonary meridian; **Fig. 3d**)⁶⁾, which makes this a controlled study.

The stimulation of the acupoints was carried out in a randomized order. The hypothesis was that the invisible (special protective goggles) and non perceptible yellow laser stimulation might affect BP, HR and/or HRV.

Temperature measurements

For the temperature measurements on the skin surface around the acupoints we used a Flir i7 (Flir Systems, Wilsonville, USA) infrared camera. This thermal imaging camera operates at a wavelength range from 7.5 - 13 μ m. The focal distance of the infrared lens is $f=6.8$ mm. The temperature measurement range is between -20 °C

and +250 °C and the sensitivity is determined <0.1 °C at 30 °C. The accuracy of the Flir i7 infrared camera lies at ± 2% of the reading and the infrared resolution is 140x140 pixel. The system is ready for use in 15 - 20 seconds after pressing the power-on button. The locations for the thermographic measurements were the areas around the acupoints Baihui, Neiguan, Taichong and the placebo point. In this area, the highest temperature value within the ROI (region of interest) was included in the analysis. All areas were measured before, during, and after stimulation with the yellow laser. The procedure of a thermographic measurement at the point Baihui can be seen in **Fig. 3a**.

Electrocardiographic measurements

For the electrocardiographic measurements three adhesive electrodes (Skintact Premier F-55; Leonhard Lang GmbH, Innsbruck, Austria) which are applied to the chest, were used. The duration of RR-intervals is measured during time periods of 5 min, and on spectral analysis basis HRV is determined.

For the registration of the electrocardiogram (ECG) a medilog AR12 HRV (Huntleigh Healthcare, Cardiff, United Kingdom) system is used. The system has a sampling rate of 4096 Hz, ⁷⁾ and the raw data are stored on a memory card. Mean HR, total HRV, and the LF/HF ratio of HRV were chosen as preliminary electrocardiographic evaluation parameters, as such being recommended by the Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology. ⁸⁾

Procedure

The volunteers were asked to lie down on a bed in one of our labs. Before starting the laser stimulation, BP was measured at the left wrist (blood pressure monitor HGN, Medisana AG, Neuss, Germany; range 0 – 300 mmHg), and a questionnaire about the current stress level was completed by the volunteers. After this procedure, a resting phase of at least 5 min was kept in order to obtain steady-state conditions. After this 5 min period the electrocardiographic recording started (see **Fig. 4**, Resting state). During the last 2 minutes of this phase, thermographic pictures of all points were taken. The first registered 5 min-phase of the ECG thus represents the baseline values. Then, the acupuncture points and the placebo point were stimulated for 5 min each in randomized order; during the stimulation, thermal images were taken of the respective point.

The last 5 min of the ECG recording served as control and resting phase. Again, during the last 2 minutes, thermographic pictures were taken. After a total

of 30 minutes, the electrocardiographic recording was stopped. Immediately after stopping the recording, the BP was measured again, and the questionnaire about the stress level was also completed again. The exact procedure can be seen in **Fig. 4**.

Statistical analysis

Data were analyzed using one-way repeated measures ANOVA or paired t-test. As post hoc analysis, Tukey test was used (SigmaPlot 12.0, Systat, Chicago, USA). The level of significance was defined as $p < 0.05$.

Results

Figures 5 and 6 show the results of the BP measurements before and after yellow laser acupuncture at the three acupoints. It can be seen that the systolic BP decreased significantly (**Fig. 5**). The mean diastolic BP also decreased, but not significantly (**Fig. 6**).

In addition to the BP measurements, we also evaluated the mean HR during the whole measurement session. This parameter remained almost constant, although a small decrease from 65.7 bpm (beats per minute) to 64.5 bpm could be seen (see **Table 1**).

We detected HRV during the whole measurement session of 30 min. Table 1 shows the decrease (n.s.) of the HRV from the beginning to the end of the measurement.

The comparison of female and male related to HR and HRV is also shown in **table 1**.

In line with the HRV measurement we also investigated the LF/HF value. The analysis showed that this parameter increased significantly after yellow laser acupuncture (see **Fig. 7**).

Another parameter detected within this study was the skin surface temperature of the subjects. Every volunteer was measured three times at the given acupoints as described already in the methods. The room temperature was nearly constant all over the measurement periods (24 °C).

The summarized data of the thermal imaging can be seen in **table 2**.

Analysis shows a statistical significance in almost every case. There is a statistically significant decrease of temperature during the stimulation (“during” in **Table 2**) in comparison to the beginning (“before”) for every single point. Furthermore, the following increase of the temperature (“after”) is also significant for every point, except Baihui. Here we also detected an increase of temperature after the stimulation, but it was not significant anymore (from 30.6 to 31.4 °C). There is no significance related to the temperature at the start-

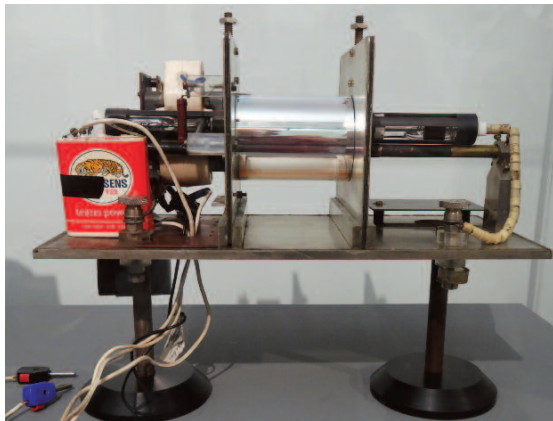


Fig. 1: First laser in Graz developed by F. Aussenegg (December 1964).



Fig. 2: New system for yellow laser needle acupuncture at the Medical University of Graz.

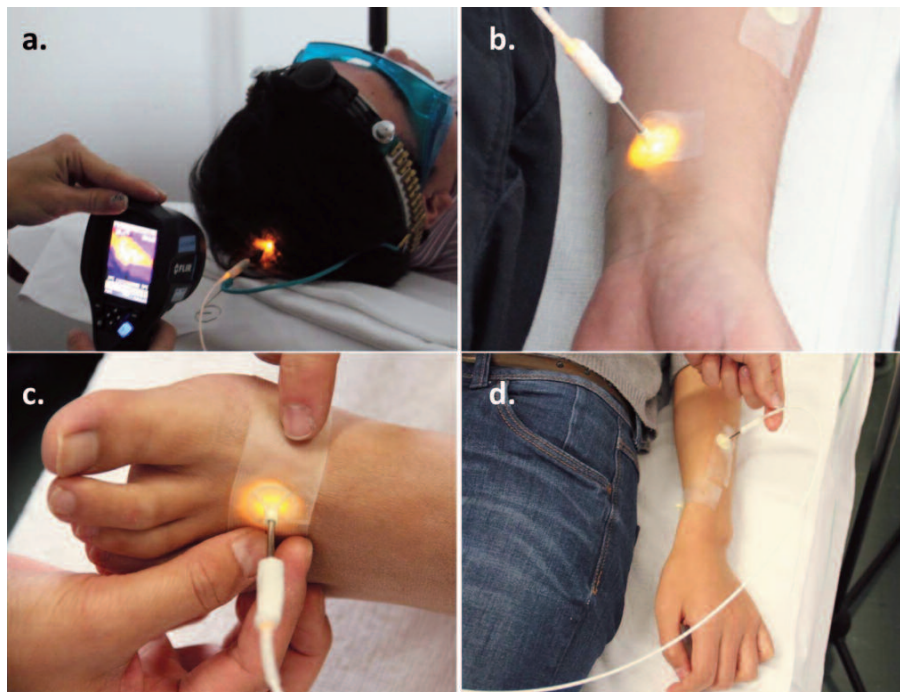


Fig. 3: Yellow laser stimulation at the acupoints Baihui (a), Neiguan (b), Taichong (c) and a placebo point (d).

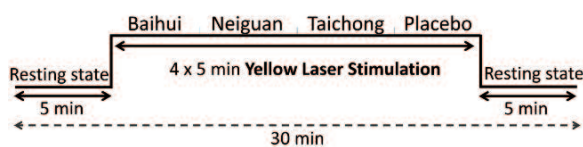


Fig. 4: Measurement procedure.

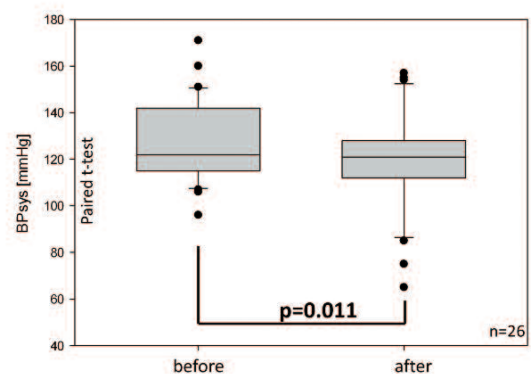


Fig. 5: Changes of systolic BP in all 26 volunteers before and after yellow laser acupuncture. The line in the box represents the median, the ends of the boxes the 25th and 75th percentile, and the error bars the 10th and 90th percentile; dots represent outliers.

ing time vs. after the stimulation.

A typical example of the results of thermal imaging is shown in **Fig 8**. It shows the temperature decrease (31.4 °C) during the stimulation in comparison to the starting time (34.9 °C) for the ROI of the acupoint Neiguan. The renewed increase (34.1 °C) of the temperature during the resting phase after the stim-

ulation can also be seen. The next figure (**Fig. 9**) shows similar results for the acupoint Taichong. There was also a notable temperature decrease (from 33.4 °C to 30.9 °C) during the stimulation phase and a renewed increase (33.4 °C) of the temperature after the stimulation. The data from Baihui and the placebo point also show similar results (**Figs. 10 and 11**).

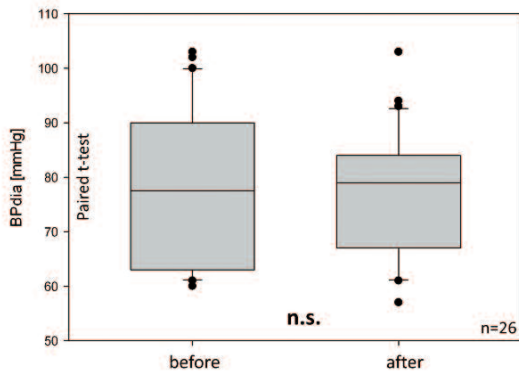


Fig. 6: Changes of diastolic BP in all 26 volunteers before and after yellow laser acupuncture. For further explanations, see Fig. 5.

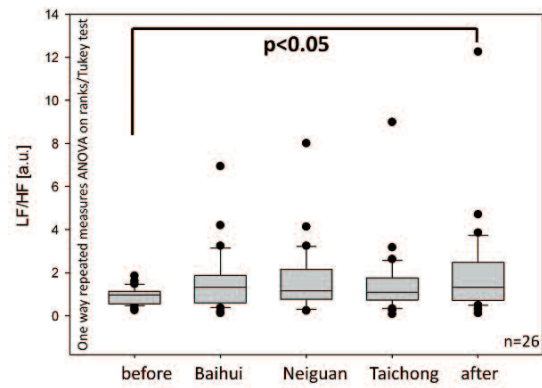


Fig. 7: Results of the LF/HF value analysis before and after yellow laser acupuncture. Further explanations: see Fig. 5.

Neiguan Volunteer 12

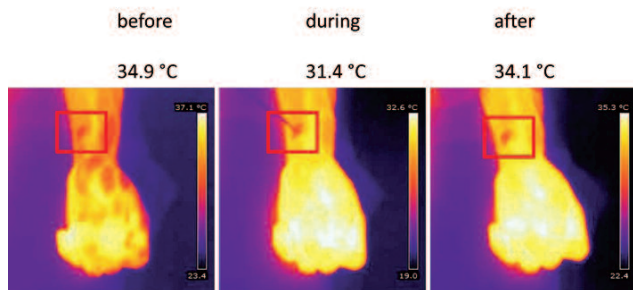


Fig. 8: Three thermal images from a 21-year-old male volunteer before, during and after yellow laser stimulation at the acupoint Neiguan.

Taichong Volunteer 10

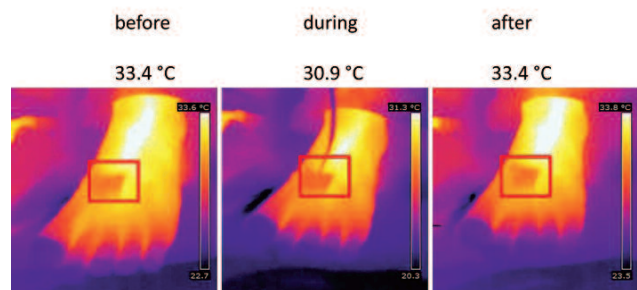


Fig. 9: Three thermal images from a 25-year-old male volunteer before, during and after yellow laser stimulation at the acupoint Taichong.

Baihui Volunteer 12

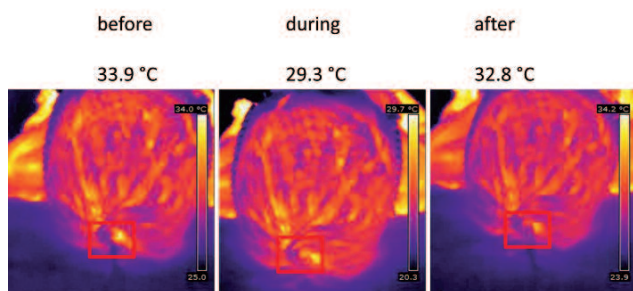


Fig. 10: Three thermal images from a 21-year-old male volunteer before, during and after yellow laser stimulation at the acupoint Baihui.

Placebo Volunteer 12

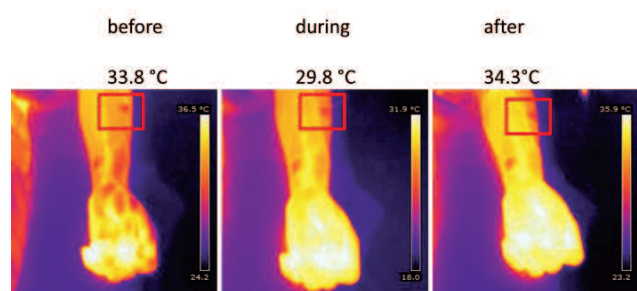


Fig. 11: Three thermal images from a 21-year-old male volunteer before, during and after yellow laser stimulation at a placebo point.

Table 1: HR and HRV values are demonstrated. Note the decrease of HR and the increase of HRV.

	all (n=26)	women (n=13)	men (n=13)
HR start [bpm]	65.7±10.9	64.5±10.8	66.8±11.2
HR Baihui [bpm]	65.0±10.4	63.3±9.5	66.7±11.4
HR Neiguan [bpm]	64.6±10.5	62.9±9.3	66.4±11.6
HR Taichong [bpm]	64.1±9.3	62.4±8.4	65.8±10.2
HR Placebo [bpm]	64.6±10.3	62.9±9.5	66.2±11.1
HR end [bpm]	64.5±10.0	63.0±8.7	66.1±11.2
total HRV start [a.u.]	4085.8±2938.0	3834.1±2696.2	4337.5±3252.2
total HRV Baihui [a.u.]	3899.0±2972.9	3311.9±2383.3	4486.2±3462.1
total HRV Neiguan [a.u.]	4236.2±2972.8	3467.4±2335.6	5005.0±3416.9
total HRV Taichong [a.u.]	4258.6±3613.4	3814.9±3155.4	4702.3±4100.9
total HRV Placebo [a.u.]	4039.2±3077.8	3255.5±2795.3	4822.9±3254.3
total HRV end [a.u.]	4439.6±3367.4	3600.2±2532.4	5279.1±3960.3

Values are given as mean ± standard deviation (SD). bpm ... beats per minute; a.u. ... arbitrary units

Table 2: Values of temperature measurements are demonstrated.

Temp. [°C]	Baihui	Neiguan	Taichong	Placebo
before	31.904	33.788	31.485	33.308
during	30.558	31.146	28.988	30.727
after	31.446	33.542	30.669	33.081

In addition to these parameters we also asked the volunteers to fill in a questionnaire about their current stress level. These reports were categorized at a scale from 0 to 10 (0: positive, comfortable, and relaxed; 10: negative, uncomfortable, and anxious). **Figure 12** shows the results of this questionnaire. As a result it can be stated that the stress level of the volunteers decreased significantly. In addition to the analysis of all 26 volunteers, we also compared the stress level of women and men. For both cases there was a statistical significance related to the decrease of stress shown (f: $p=0.031$; m: $p=0.008$).

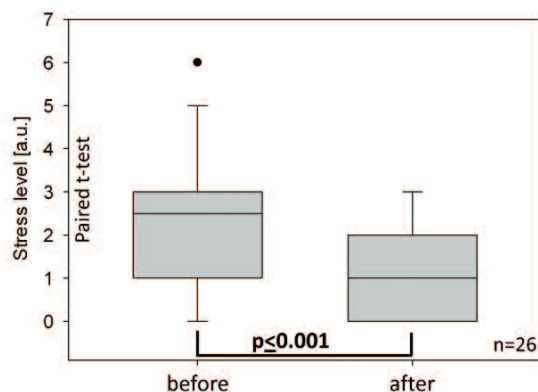


Fig. 12: Significant results of the stresslevel questionnaire before and after yellow laser acupuncture. For further explanations, see Fig. 5.

Discussion

Lifestyle-related diseases are a big problem in our society. For example stroke is one of the leading causes of death worldwide. But not only the elderly population is affected by this kind of diseases, also more and more young people are among the patients. A previous study had proven that the yellow laser could penetrate the skull, and therefore might be a promising new approach for the noninvasive stroke therapy.⁹⁾ Also dementia, another so called lifestyle-related disease, is a big problem for our population. Mainly because of the movement in the age pyramid, experts assume that the incidence of dementia will show an enormous increase in the coming decades.¹⁰⁾

Another big problem, which is related to many of those lifestyle-related diseases, is hypertonic blood pressure. In our study, which is the first trial worldwide using yellow laser acupuncture, we wanted to investigate the effects of yellow laser on BP in volunteers. A significant decrease of the systolic BP was found. This might be an effect of the combination of all acupoints we used. Therefore one can assume that stimulation with yellow laser on the acupoints Baihui, Neiguan and Taichong could be useful in the treatment of hypertonic patients. We also compared the difference between female and male volunteers. In women the systolic BP decreased significantly, but not in men. This could appear because women might be more sensitive to the effects of yellow laser. Diastolic BP also decreased, but not significantly. Specific effects of laser stimulation on high BP have been reported in several studies.¹¹⁾

Hong et al., for example, reported in 2014 about 126 cases of grade 1 essential hypertension.¹¹⁾ They investigated different treatment methods. Beside a musical treatment group, laser acupuncture was also used once a day with positive effects. Similar to our study, the main acupuncture point was Taichong.¹¹⁾

In another study, Zhang et al.¹²⁾ investigated the influence of laser acupuncture on high blood pressure. The authors from the USA and Europe concluded that low-level infrared laser acupuncture treatment of acupoints Hegu and Quchi resulted in lower blood pressure. Although the acupoints used in this study are different from those in our present investigation, a similar treatment duration (4 min) was used for each point (in our study: 5 min). In addition, Zhang et al.¹²⁾ did not observe a significant difference in body weight or HRV after laser acupuncture treatment. They applied laser treatment for 90 days (at least 12 treatments per subject). In our study, only acute (short term) effects were measured. However, we also found significant decreases in BP after only one treatment and no significant changes in total HRV, similar to the results of Zhang et al.¹²⁾ In another study, however, our group could provide evidence that there is a beneficial effect on HRV in patients with hypertension, and that there are some effects of laterality of the acupoint Quchi.¹³⁾

The demonstration of these short term effects can also have clinical significance; researchers from Russia report about the efficacy of laser acupuncture in controlling hypertensive crises in patients suffering from hypertensive diseases.¹⁴⁾ They also stated that laser therapy was more effective in patients with moderate and significant hypertrophy of the left ventricle compared to patients showing marked hypertrophy of the

left ventricle.¹⁴⁾

HRV is used worldwide as a reliable indicator of the state of health. Special lifestyle related processes like stress or burnout could be counteracted by using different preventive methods like acupuncture. This could be demonstrated in previous investigations.¹⁵⁾

The results of our present investigation did not show significant differences regarding the total HRV in general. Nevertheless an overall increase of HRV was notable. This could be explained by the decreasing effect of the yellow laser on BP. Also the combination of the three acupoints should be useful. If we compare all single 5 min fragments, it can be seen that the highest variability is achieved at the end of the measurement and at the acupoints Neiguan and Taichong. For the treatment of hypertensive patients, a combination of the three acupoints and a simultaneous and continuous stimulation over a longer treatment period is therefore recommended.

We also investigated the LF/HF value. This parameter increased significantly. Taking into account the data of the thermographic measurements, there could be some possible explanations related to this. There was a significant temperature decrease during the stimulation and a significant increase after the stimulation. A higher LF/HF value indicates an increased function of the sympathetic system. The decreased surface temperature could be an indicator for a vasoconstriction in the vessels, and because of this there might be an increased function of the sympathetic system.⁸⁾

Within the LF band, the so-called “10-second-rhythm” (approx. 0.05 – 0.15 Hz) is manifested. This is related to the natural rhythm of cardiovascular active neurons in the lower brainstem. Analogous blood pressure waves (blood pressure waves of third order) prove the connection.^{7, 8, 16)}

“HRV is associated with blood pressure levels, however, very few studies have correlated HRV to lifestyle in general population.”¹⁷⁾ This statement was made by authors from Japan in 2014.¹⁷⁾ They investigated 2040 women and 1418 men, aged 40 – 74 years, and measured HRV in the time and frequency domain, also using a 5-min RR interval recording as in our study. HRV indices in this study were not associated with systolic blood pressure levels in men, whereas in women, different HRV parameters were associated with a decrease in systolic blood pressure. The data of this study suggest that HRV reflects diastolic BP better than systolic BP levels for both sexes, and that alcohol intake strongly affects systolic BP levels in men.¹⁷⁾

Our results of the temperature measurements in this study showed that there is a significant decrease of

temperature during the stimulation with the yellow laser. Afterwards the temperature increases again. This effect has not been investigated in detail in scientific literature up to now. However, we found similar results in an animal experimental study. For this experiment in rats, red laser light (wavelength 658 nm, output power 40 mW, diameter 500 µm, duration 10 min) at Baihui and Zusanli also induced significant decreases in temperature values.¹⁸⁾ As stated in that paper, the mechanisms underlying these results are currently unknown, but brain stimulation (via laser or mechanical pressure) and mainly direct central mechanisms may be responsible for the local and peripheral temperature decrease.¹⁸⁾ Maybe the mechanisms are similar in the animal and the human experimental study. Quirico et al.¹⁹⁾ for example, also found that e.g. Taichong induced a rapid and marked vasoconstriction.

In the study we also analyzed the results of the stresslevel questionnaire. One can assume that yellow laser stimulation has a positive effect concerning the stresslevel. The volunteers felt significantly more com-

fortable after the measurement procedure. This positive effect of the yellow laser in combination with the three acupoints needs further investigation. This procedure can be performed in a double blind way. The volunteers or patients do not feel the stimulation and also the investigators need not be informed about active or deactivated yellow laser stimulation.

Conclusion

For the first time, yellow laser acupuncture was used in a scientific study. The stimulation of yellow laser on the combination of the acupoints Baihui, Neiguan and Taichong has a significant positive effect on BP and the well-being of the volunteers. In addition, HRV - especially the LF/HF ratio - was also influenced significantly. The first results are very promising, and therefore further studies on the topic of yellow laser acupuncture will follow soon. The results can be very important especially for the treatment of lifestyle related diseases.

References

- 1: Litscher G: Wissenschaftliche Aspekte der integrativen Lasermedizin. In: (Bahr F, and Litscher G) Laserakupunktur und innovative Lasermedizin. 2015, Elsevier, München. In press.
- 2: Litscher D (2015): Yellow laser acupuncture for prevention and early intervention of lifestyle related diseases. Proceedings of the 2nd World Congress of High-Tech Acupuncture and Integrative Medicine, Hangzhou, China, May 22-24, 2015; in press.
- 3: Weber M, Weber R, and Junggebauer M: Medizinische Low-Level-Lasertherapie – Grundlagen und klinische Anwendung. 2014. pp 154 - 156.
- 4: Zhang J, Zhao BX, and Lao LX: Acupuncture and Moxibustion. 2014, People's Medical Publishing House, Beijing.
- 5: Stux G and Pomeranz B: Basics of Acupuncture. 1998, Springer, Berlin Heidelberg New York.
- 6: Litscher G and Schikora D (2002): NIRS for objectifying cerebral effects of needle and laserneedle acupuncture. Spectroscopy, 16: 335 - 342.
- 7: Litscher G and Litscher D (2010): 'Fire of Life' analysis of heart rate variability during alpine skiing in Austria. North American Journal of Medical Sciences, 2(6): 258 - 262.
- 8: Task force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology (1996): Heart rate variability: Standards of measurement, physiological interpretation and clinical use. European Heart Journal, 17(3): 354 - 381.
- 9: Litscher D and Litscher G (2013): Laser therapy and stroke: Quantification of methodological requirements in consideration of yellow laser. International Journal of Photoenergy, 2013, Article ID 575798.
- 10: Litscher D and Litscher G (2014): Laser therapy and dementia: A database analysis and future aspects on LED-based systems. International Journal of Photoenergy, 2014, Article ID 268354.
- 11: Hong HY, Chen YS, Hong ZS, Shi JL, Yang ZB, Chen ZB, and Zhan HR (2014): Clinical research on electrode and laser stimulating on acupoint combined with music therapy for grade 1 essential hypertension. Zhongguo Zhen Jiu, 34 (7): 713 - 716.
- 12: Zhang J, Marquina N, Oxinos G, Sau A, and Ng D (2008): Effect of laser acupoint treatment on blood pressure and body weight – a pilot study. Journal of Chiropractic Medicine, 7 (4): 134 - 139.
- 13: Litscher G, Cheng WP, Cheng GY, Wang L, Zhao J, Litscher D, Gaischek I, Sheng Z, and Kuang H

- (2014): Acupuncture point laterality: Investigation of acute effects of Quchi (LI11) in patients with hypertension using heart rate variability. *Evidence-based Complementary and Alternative Medicine*, 2014: Article ID 979067.
- 14: Odud AM and Potapenko PI (1991): The use of laser puncture for managing hypertensive crises. *Vrachebnoe Delo*, 7: 34 - 36.
- 15: Litscher G, Liu CZ, Wang L, Wang LP, Li QQ, Shi GX, Gaischek I, Litscher D, and Wang XM (2013): Improvement of the dynamic responses of heart rate variability patterns after needle and laser acupuncture treatment in patients with burn out syndrome: a transcontinental comparative study. *Evidence-based Complementary and Alternative Medicine*, 2013: Article ID 128721.
- 16: Maud PJ and Foster C (editors): *Physiological assessment of human fitness*. 2006, Human Kinetics, Champaign.
- 17: Mori H, Saito I, Eguchi E, Maruyama K, Kato T, and Tanigawa T (2014): Heart rate variability and blood pressure among Japanese men and women: a community-based cross-sectional study. *Hypertension Research*; Epub ahead of print. Doi: 10.1038/hr.2014.73.
- 18: Litscher D, Wang XY, Schneider M, Friemel CM, and Litscher G (2014): Inhibitory effects of 658 nm laser irradiation on skin temperature in anesthetized rats: Preliminary results from a controlled study. *International Journal of Photoenergy*, 2014, Article ID 275765.
- 19: Quirico PE, Allais G, Ferrando M, de Lorenzo C, Burzio C, Bergandi F, Rolando S, Schiapparelli P, and Benedetto C (2014): Effects of the acupoints PC6 Neiguan and LR 3 Taichong on cerebral blood flow in normal subjects and in migraine patients. *Neurological Sciences*, 35 (S1): S129 - S133.

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