Laser Acupuncture

Abstracts - Gerhard Litscher

Crit Rev Biomed Eng. 2007;35(3-4):183-95.

Bioengineering assessment of acupuncture, part 7: heart rate variability.

Litscher G.

Research Unit of Biomedical Engineering in Anesthesia and Intensive Care Medicine and Traditional Chinese Medicine (TCM Research Center), Medical University of Graz, Graz, Austria. gerhard.litscher@medunigraz.at

In the seventh part of this review article, preliminary research on the topic of acupuncture and heart rate variability is described. Heart rate variability (HRV) refers to the beat-to-beat alterations in heart rate. Under resting conditions, the electrocardiograms of healthy people exhibit periodic variations in the percentage change in sequential chamber complexes (RR-intervals). The parameter HRV is modulated by the blood-pressure control-system, influences from the hypothalamus, and, in particular, the vagal cardiovascular center in the lower brainstem. This review article contains a short summary of scientific literature on HRV and acupuncture.

Crit Rev Biomed Eng. 2007;35(1-2):1-36.

Bioengineering assessment of acupuncture, Part 6: monitoring--neurophysiology.

Litscher G.

Research Unit of Biomedical Engineering in Anesthesia and Intensive Care Medicine, Medical University of Graz, Graz, Austria.

Neurophysiological monitoring using spontaneous and evoked bioelectrical brain activities provides functional assessment of the central nervous system. This sixth part of the review article summarizes results from electroencephalographic and evoked potential monitoring in connection with acupuncture. The article reflects the impact of new techniques on acupuncture research (e.g., 600 Hz oscillations). Although numerous

questions concerning acupuncture remain still unsolved, the present findings could be a further step to discover the complex mechanisms underlying the effects of acupuncture.

Crit Rev Biomed Eng. 2006;34(6):439-57.

Bioengineering assessment of acupuncture, part 5: cerebral near-infrared spectroscopy.

Litscher G.

Research Unit of Biomedical Engineering in Anesthesia and Intensive Care Medicine, Medical University of Graz, Graz, Austria. gerhard.litscher@meduni-graz.at

The assessment of cortical activation in the brain due to acupuncture is crucial. Thus far functional assessment of cortical responses to certain external stimuli (for examples, manual needle, optical, electrical) are very few due to the lack of suitable techniques to monitor changes of brain activities. Near-infrared spectroscopy has been found to be suitable for functional studies during acupuncture. By this neuromonitoring method, hemodynamic changes coupled to cortical activity can be monitored. Near-infrared spectroscopy is used to measure regional changes in oxyhemoglobin, deoxyhemoglobin, and cytochrome aa3 noninvasively and continuously. The studies in this fifth part of a review article, which have been carried out mainly by the research group of Biomedical Engineering in Anesthesia and Intensive Care Medicine at the Medical University of Graz, demonstrate that near-infrared spectroscopy is a suitable technique for the assessment of cortical changes in response to varying forms of acupuncture. The method is likely to play an important role in providing new insights into the effects of acupuncture on brain function.

Crit Rev Biomed Eng. 2006;34(4):327-45.

Bioengineering assessment of acupuncture, part 4: functional magnetic resonance imaging.

Litscher G.

Research Unit of Biomedical Engineering in Anesthesia and Intensive Care Medicine, Medical University of Graz, Auenbruggerplatz, Graz, Austria. gerhard.litscher@meduni-graz.at

In the fourth part of this review article, research on the topic of acupuncture and functional magnetic resonance imaging is described. Needle as well as painless laserneedle stimulation have led to significant changes in different areas of the brain. With the help of modern biomedical engineering equipment and neuroscience, some of

acupuncture's secrets have begun to be revealed. The neuro-modulating effects require further investigation in a larger population sample.

Crit Rev Biomed Eng. 2006;34(4):295-326.

Bioengineering assessment of acupuncture, part 3: ultrasound.

Litscher G.

Research Unit of Biomedical Engineering in Anesthesia and Intensive Care Medicine, Medical University of Graz, Auenbruggerplatz, Graz, Austria. gerhard.litscher@meduni-graz.at

Multidirectional transcranial ultrasound monitoring can be used to prove quantifiable effects of acupuncture stimulation in the brain. This third part of the review article gives a short introduction in monitoring cerebral blood flow velocity and summarizes the scientific results in this area of research. New constructions from the Medical University of Graz that can be used for evidence-based computer-controlled acupuncture are described. With these new methods and concepts, reproducible effects of needle and laserneedle acupuncture stimulation in cerebral blood flow velocity can be objectified for the first time.

Crit Rev Biomed Eng. 2006;34(4):273-94.

Bioengineering assessment of acupuncture, part 2: monitoring of microcirculation.

Litscher G.

Research Unit of Biomedical Engineering in Anesthesia and Intensive Care Medicine, Medical University of Graz, Auenbruggerplatz, Graz, Austria. gerhard.litscher@meduni-graz.at

In the second part of the review article, monitoring of microcirculation during acupuncture is described. Laser Doppler flowmetry and laser Doppler imaging provide easy-to-use, noninvasive, real-time measurements of local tissue blood flow. Using these types of biomedical equipment, it is possible to quantify and objectify peripheral changes in microcirculation during different methods of acupuncture stimulation (manual needle acupuncture and laserneedle acupuncture).

Crit Rev Biomed Eng. 2006;34(1):1-22.

Bioengineering assessment of acupuncture, part 1: thermography.

Litscher G.

Research Unit of Biomedical Engineering in Anesthesia and Intensive Care Medicine, Medical University of Graz, Graz, Austria. gerhard.litscher@meduni-graz.at

In Western society, acupuncture is becoming a popular complementary method to medical treatment. However, a scientific understanding of acupuncture has not been completely developed but will absolutely be necessary for the increased acceptance of acupuncture by the Western medical community. This first part of the review article describes, in a general introduction, milestones of acupuncture research within the last 30 years and in a specific part the possibilities and limitations of infrared thermography, a noninvasive biomedical engineering method, within acupuncture research.

Anesth Analg. 2006 Jun;102(6):1745-51.

Electroencephalogram--entropy and acupuncture.

Litscher G.

Research Unit of Biomedical Engineering in Anesthesia and Intensive Care Medicine, Medical University of Graz, Graz, Austria. gerhard.litscher@meduni-graz.at

Computer-based measuring of the level of sedation and hypnosis is difficult and has proven to be challenging. The electroencephalogram (EEG) has been proposed as a potential method. Response entropy (RE) and state entropy (SE) are multifactor, dimensionless parameters of a new technology of EEG monitoring, and we investigated them for the first time in acupuncture research within this study. Both parameters have been alleged to reflect changes in the clinical state of sedation. Two different acupuncture schemes were tested in a randomized crossover trial with nine healthy volunteers (mean age +/- sd, 28.8 +/- 3.6 yr; 25-36 yr). Applying and stimulating acupuncture needles or performing laserneedle acupuncture at special sedation points decreased RE and SE significantly ($P < \text{or} = 0.01$; paired t-test) compared with the reference interval before acupuncture. In contrast, acupuncture of points for increasing "Qi-energy" did not decrease parameters of entropy. Specific acupuncture schemes produce specific, reproducible, and quantifiable effects on entropy parameters in the EEG. Therefore, entropy measurements during acupuncture seem to be worthy of further evaluation with a larger series of subjects.

Biomed Eng Online. 2005 Jun 15;4(1):38.

Infrared thermography fails to visualize stimulation-induced meridian-like structures.

Litscher G.

Biomedical Engineering and Research in Anesthesia and Intensive Care Medicine, Medical University of Graz, Austria. gerhard.litscher@meduni-graz.at

BACKGROUND: According to Traditional Chinese Medicine (TCM) the vital energy flows through a system of channels also called meridians. Generally accepted proof for meridians cannot be considered as being given. Goal of this study was to examine whether possible stimulation-induced meridian-like structures, as recently described by other authors, can be visualized and objectified simultaneously at different infrared wavelength ranges. METHODS: The study analyses evidence for the existence of acupuncture-specific, meridian-like artifacts in 6 healthy volunteers (mean age +/- SD 28.7 +/- 3.7 years; range 25 - 35 years). Two infrared cameras at different wavelength ranges were used for thermographic control of possible stimulation effects (moxibustion-cigar, infrared warmth stimulation, needle and laserneedle stimulation). In addition to thermography, temperature and microcirculatory parameters were registered at a selected point using laser-Doppler flowmetry. RESULTS AND CONCLUSION: After moxibustion (or infrared light stimulation) of the body at 2 - 5 microm and 7.5 - 13 microm ranges, different structures appear on thermographic images of the human body which are technical artifacts and which are not identical to what are known as meridians in all textbooks of TCM. Further scientific studies are required regarding the possible visualization of meridians.

Neurol Res. 2005 Jun;27(4):423-8.

An NIRS matrix for detecting and correcting cerebral oxygen desaturation events during surgery and neuroendovascular procedures.

Schwarz G, **Litscher G**, **Delgado PA**, **Klein GE**.

Department of Anesthesiology and Critical Care, Medical University of Graz, Austria. gerhard.schwarz@meduni-graz.at

BACKGROUND: Transcranial cerebral oximetry was developed for early detection of cerebral hypoxia and to avoid cerebral dysfunctions. However, near infrared spectroscopy (NIRS) data obtained during surgery are subject to intrinsic and extrinsic influences that have to be accounted for when interpreting the recordings. METHODS: We developed an NIRS matrix to provide brief information for specific intervention to correct changes of cerebral oxygen saturation (COS). Selected vital data and the descriptors of cerebrovascular and neurofunctional status were linked to logistic chains. RESULTS:

The matrix is horizontally and vertically grouped and contains five descriptors: 1. change of COS; 2. key variable (parameter related to the change of COS); 3. associated parameters (vital data that do not cause COS alterations); 4. interpretation of values or preconditions most probably due to COS changes; and 5. the intervention most likely to normalize the COS or return it to baseline. The descriptors are grouped horizontally to a logistics chain. CONCLUSION: The modular expandable NIRS matrix we describe has promise for clinical use in surgical, neurointerventional, and anaesthesiological contexts.

Neurol Res. 2004 Sep;26(6):698-701.

Pseudoparadoxical dissociation of cerebral oxygen saturation and cerebral blood flow velocity after acupuncture in a woman with cerebrovascular dementia: a case report.

Schwarz G, **Litscher G**, **Sandner-Kiesling A**.

Department of Anaesthesiology for Neurosurgical and Craniofacial Surgery and Intensive Care, Medical University of Graz, Austria. gerhard.schwartz@uni-graz.at

Acupuncture can increase both cerebral oxygen saturation and cerebral blood flow velocity. We describe a 77-year-old woman with cerebrovascular dementia in whom acupuncture reproducibly induced an increase of blood flow velocity but a decrease of regional oxygen saturation. At four of 11 acupuncture sessions, blood flow velocity was measured in the middle cerebral artery with transcranial Doppler sonography and cerebral regional oxygen saturation (rSO(2)) with transcranial near infrared spectroscopy. Cerebral blood flow velocity increased by an average of 20% (range: 7-27%) at all four study points whereas rSO(2) consistently decreased by an average of 7% (range: 4-13%). Clinical status and cognitive function improved. These findings in a patient with vascular dementia may suggest increased oxygen extraction by activated neuronal structures.

Lasers Med Sci. 2004;19(1):6-11. Epub 2004 Mar 31.

Acupuncture using laser needles modulates brain function: first evidence from functional transcranial Doppler sonography and functional magnetic resonance imaging.

Litscher G, **Rachbauer D**, **Ropele S**, **Wang L**, **Schikora D**, **Fazekas F**, **Ebner F**.

Department of Biomedical Engineering and Research in Anesthesia and Critical Care, Medical University of Graz, Auenbruggerplatz 29, 8036, Austria.
gerhard.litscher@meduni-graz.at

Acupuncture using laser needles is a new totally painless stimulation method which has been described for the first time. This paper presents an experimental double-blind study in acupuncture research in healthy volunteers using a new optical stimulation method. We investigated 18 healthy volunteers (mean age +/- SD: 25.4 +/- 4.3 years; range: 21-30 years; 11 female, 7 male) in a randomized controlled cross-over trial using functional multidirectional transcranial ultrasound Doppler sonography (fTCD; n = 17) and performed functional magnetic resonance imaging (fMRI) in one volunteer. Stimulation of vision-related acupoints resulted in an increase of mean blood flow velocity in the posterior cerebral artery measured by fTCD [before stimulation (mean +/- SE): 42.2 +/- 2.5; during stimulation: 44.2 +/- 2.6; after stimulation: 42.3 +/- 2.4 cm/s, n.s.]. Mean blood flow velocity in the middle cerebral artery decreased insignificantly. Significant changes ($p < 0.05$) of brain activity were demonstrated in the occipital and frontal gyrus by fMRI. Optical stimulation using properly adjusted laser needles has the advantage that the stimulation cannot be felt by the patient (painless and no tactile stimulation) and the operator may also be unaware of whether the stimulation system is active. Therefore true double-blind studies in acupuncture research can be performed.

Biomed Tech (Berl). 2004 Jan-Feb;49(1-2):2-5.

[Histological investigation of the micromorphological effects of the application of a laser needle--results of an animal experiment]

[Article in German]

Litscher G, **Nemetz W**, **Smolle J**, **Schwarz G**, **Schikora D**, **Uranüs S**.

Abteilung für Biomedizintechnische Forschung in Anästhesie und Intensivmedizin, Medizinische Universität Graz. gerhard.litscher@meduni-graz.at

In an experimental animal study (Sus scrofa domesticus) we investigated the effects of the new technique of laser needle stimulation (wavelength: 685 nm; energy density: 4.6 kJ/cm2 per point; application duration: 20 min). The results revealed changes in microcirculatory parameters of the skin resulting in an increase in blood flow. However, the quality and intensity of the laser light did not induce micromorphological alterations in the skin.

Eur J Anaesthesiol. 2004 Jan;21(1):13-9.

Effects of acupressure, manual acupuncture and Laserneedle acupuncture on EEG bispectral index and spectral edge frequency in healthy volunteers.

Litscher G.

University of Graz, Department of Biomedical Engineering and Research in Anesthesia and Intensive Care, Graz, Austria. gerhard.litscher@uni-graz.at

BACKGROUND AND OBJECTIVE: The main purpose of this study was to investigate the effects of sensory (acupressure and acupuncture) and optical stimulation (Laserneedle acupuncture) on electroencephalographic bispectral index, spectral edge frequency and a verbal sedation score. METHODS: Twenty-five healthy volunteers (mean age +/- SD: 25.5 +/- 4.0yr) were investigated during the awake state. The acupuncture point Yintang and a placebo control point were stimulated. The study was performed as a randomized, controlled and partly blinded cross-over trial. RESULTS: Bispectral index and spectral edge frequency values both decreased significantly ($P < 0.001$) during acupressure on Yintang to values of 62.9 (minimum 35) +/- 13.9 bispectral index and to 13.3 (minimum 2.9) +/- 8.1 Hz (spectral edge frequency right) and 13.8 (minimum 2.7) +/- 7.3 Hz (spectral edge frequency left), respectively. Bispectral index was also significantly ($P < 0.05$) affected by Laserneedle acupuncture and acupressure on the control point but the changes were not clinically relevant, 95.4 +/- 4 and 94.2 +/- 4.8, respectively. All interventions significantly (Yintang: $P < 0.001$; control point: $P < 0.012$) reduced verbal sedation score. CONCLUSIONS: The study highlights the electroencephalographic similarities of acupressure induced sedation and general anaesthesia as assessed by bispectral index and spectral edge frequency.

Neurol Res. 2003 Oct;25(7):722-8.

Cerebral and peripheral effects of laser needle-stimulation.

Litscher G.

Department of Biomedical Engineering and Research in Anesthesia and Critical Care, University of Graz, Auenbruggerplatz 29, A-8036 Graz, Austria. gerhard.litscher@uni-graz.at

This study comprises scientific-theoretic fundamental investigations of laserneedle technology, a new and painless method of acupuncture stimulation. Laserneedles are not inserted in the skin, but are merely placed on the surface of the acupuncture point. The study documents the significant changes in peripheral microcirculation ($p = 0.005$) and surface temperature of the skin ($p = 0.02$) induced by laser, in 22 healthy volunteers (mean age 24.4 +/- 2.6 years). In addition, a randomised cross-over study to characterise

the specific changes in cerebral blood flow velocity with laserneedle acupuncture ($p < 0.001$) is presented. These results provide important information for characterising the effects of laserneedle acupuncture.

Lasers Med Sci. 2002;17(4):289-95.

Cerebral vascular effects of non-invasive laserneedles measured by transorbital and transtemporal Doppler sonography.

Litscher G, **Schikora D**.

Department of Biomedical Engineering and Research in Anesthesia and Critical Care, University of Graz, Austria. gerhard.litscher@uni-graz.at

Laserneedles represent a new non-invasive optical stimulation method which is described for the first time in this paper. We investigated 27 healthy volunteers (mean age+/-SD: 25.15+/-4.12 years; range: 21-38 years; 14 female, 13 male) in a randomised cross-over trial to study differences between laserneedle acupuncture and manual needle acupuncture in specific cerebral parameters. Mean blood flow velocity (v(m)) showed specific and significant increases in the ophthalmic artery during laserneedle stimulation ($p=0.01$) and during manual needle stimulation ($p<0.001$) at vision-related acupoints. At the same time insignificant alterations in v(m) were found in the middle cerebral artery for both acupuncture methods. The eight laserneedles used in this study were arranged at the end of the optical fibres. Each fibre was connected to a semiconductor laser diode emitting at 685 nm with a primary output power of about 55 mW. Optical stimulation using properly adjusted laserneedles has the advantage that the stimulation can hardly be felt by the patient and the operator may also be unaware of whether the laserneedle system is active, and therefore true double blind studies in acupuncture research can be performed.

Neurol Res. 2003 Mar;25(2):183-8.

Noninvasive assessment of cerebral oxygenation during high altitude trekking in the Nepal Himalayas (2850-5600 m).

Hadolt I, **Litscher G**.

Department of Biomedical Engineering and Research in Anesthesia and Critical Care, University of Graz, Auenbruggerplatz 29, A-8036 Graz, Austria.

Mountain trekking is significantly increasing in popularity. Hypoxia seems to play a key role in the pathogenesis of acute mountain sickness (AMS). The purpose of this study was to investigate regional cerebral (rSO2) and peripheral (SaO2) oxygen saturation for the first time, during 22 days high altitude trekking (measurement points: 3450, 4450, 4750, 5050 and 2850 m) in the Khumbu region of Nepal with near infrared spectroscopy and pulse oximetry. We examined 17 healthy volunteers 19-65 years old (8 female, 9 male; mean age +/- SD, 46.1 +/- 13.1 years). RSO2 and SaO2 were significantly ($p < 0.001$, ANOVA, Tukey test) decreased at high altitudes (4450, 4750 and 5050 m). The decrease in cerebral oxygen saturation was more pronounced at higher altitudes than in the periphery (rSO2/SaO2 = 0.56 at 5050 m). At higher altitudes (> 4450 m), two subjects showed reversible symptoms of AMS. The present data indicates that acute reduction in rSO2 values might be a primary cause of AMS, however, further studies and analysis are necessary to correlate our findings with cerebral symptom scores.