Computer-aided Neuromonitoring Techniques To Objectify The Effects Of Acupuncture In The Treatment Of Migraine

G Litscher, L Wang, G Niederwieser

Citation

G Litscher, L Wang, G Niederwieser. *Computer-aided Neuromonitoring Techniques To Objectify The Effects Of Acupuncture In The Treatment Of Migraine*. The Internet Journal of Neuromonitoring. 1999 Volume 1 Number 1.

Abstract

INTRODUCTION

The treatment of headaches using traditional Chinese methods such as acupuncture, is receiving increasing attention in Western medicine.

Migraine attacks include recurring headaches and concomitant vegetative symptoms and sometimes neurological dysfunction. The prevalence is about 18-29% in women and 6-20% in men[20]. The individual course of migraines, which occur more frequently in women, varies widley with regard to symptoms, intensity and frequency24.

In this study, we used cerebral near-infrared spectroscopy and transcranial Doppler sonography to objectify the effects of acupuncture in the brain, during experimental treatment of migraines using acupuncture.

METHOD

NEAR INFRARED SPECTROSCOPY (NIRS)

Near-infrared spectroscopy (NIRS) is a non-invasive neuromonitoring method to evaluate oxygenation in cerebral tissue through the intact skull. This non-invasive aspect could become increasingly important in acupuncture research. Reports regarding the clinical use of NIRS, for transmission measurements through the entire head were mainly in newborns and infants[19]. Recently, numerous investigatiors have used NIRS in adults, although only a tissue volume of a few cubic cenitmeters can be assessed4.

The NIRO 300 (Hamamatsu Photonics, Japan) is a newly developed monitor. In addition to changes in oxyhemoglobin (O2Hb), desoxyhemoglobin (HHb), total hemoglobin (cHb = O2Hb + HHb) und oxidized cytochrome aa3 (CtOx) measured in µMol and calculated by the Lambert-Beer principle, the NIRO 300 also determines the tissue oxygenation index (TOI) which is expressed in percent. TOI is measured with SRS (Spatial Resolved Spectroscopy), which determines the absorption coefficient of tissue from locally dependent light reduction. A detector registers emitted near-infrared light from the light source (optic fiber) into tissue at three different distances and allows calculation of TOI with the SRS algorithm.

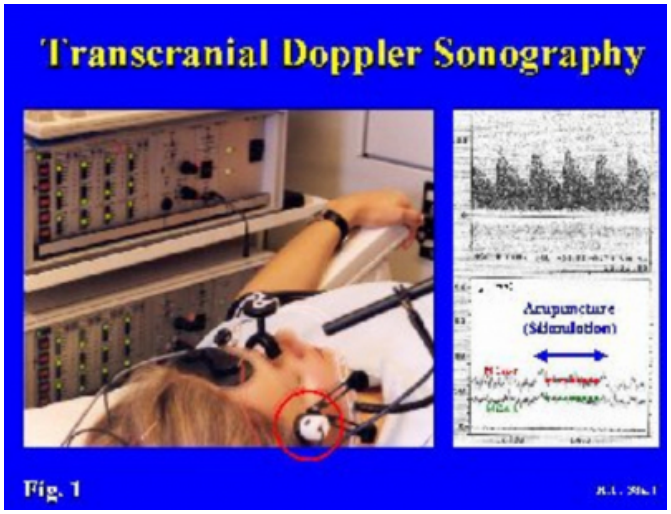
The hardware concept of the NIRO 300 of separating the central unit and the measurement unit, makes multichannel measurements possible. A silicone holder allows easy positioning of the emitter and the detecor on the head as well as reproducibility. Data (O2Hb, HHb, cHb, CtOx, TOI) are presented on a colored LCD display and a color printer.

TRANSCRANIAL DOPPLER SONOGRAPHY

In the past few years, sonographic methods for diagnosis and control in neurology, neurosurgery, anesthesiology and intensive care medicine have advanced rapidly4. Transcranial Doppler sonography (TCD) has achieved an important ranking in neurophysiologic monitoring. In this study, TCD registration was performed with a Multi Dop T and a Smart-Dop (DWL Electronic Systems GmbH, Sipplingen, Germany). 2-MHz probes with a spectacle holder were used. (Figure 1).

Figure 1

Fig. 1: Equipment for transcranial Doppler sonography and cerebral near infrared spectroscopy during acupuncture of a 38-year-old patient and the effects of acupuncture on mean blood flow velocity (vm) in the right (MCA-r) and left (MCA-l) middle cerebral artery. In addition, the flow profile of the right middle cerebral artery at a depth D = 48 cm during the stimulation phase is shown



Mean blood flow velocity (vm) is an important parameter which can be calculated from the Doppler frequency spectrum. The advantage of this measurement parameter, compared to the maximum value, lies in the interference-free determination at a poor signal-noise ratio.

TCD signals were measured continuously and changes in flow profile during the different phases of acupuncture were documented exactly and analyzed graphically and numerically.

CASE REPORT

We examined the effects of acupuncture on the oxygenation of cerebral tissue and blood flow velocity using simultaneous, multi-parametric biosignal registration in a 38-year-old woman over a period of 2 months and a total of 7 acupuncture sessions. A control measurement was performed 1 year later. The patient had intense, mainly frontal headaches. The attacks were often accompanied by sensitivity to light, pressure above the bulbi, and nausea and vomiting. The symptoms lasted up to 12 hours and showed a distinct correlation with the menstrual cycle. CT scan of the skull performed 3 days before acupuncture and the neurologic status were inconspicuous. Long-term, continuous therapy was not given and the patient took salicylates during the acupuncture phase.

The patient was informed about the procedure in detail. During the acupuncture sessions, she was placed relaxed on a bed in the biotechnology laboratory of the Department of Anesthesiology and Critical Care in Graz. The measurement devices were positioned and after a 10-minute resting time with closed eyes, the acupuncture schema showed in Figure 2 was selected.

Figure 2

Fig. 2: Acupuncture schema used in this study for migraine treatment

The acupuncture points directly on the head and the distant points on the hand and foot were needled. The following points were used: Yintang, Shuaigu, Shenmen, Hegu, Waiguan, Zusanli, Taichong and Sanyinjiao.

Stimulation was applied at normal needling depth and repeated triggering of a DeQi sensation by rotating the needle. The patient was treated once a week and the needles remained in the corresponding points for 20 minutes. During this time, all points were stimulated with a tonizing technique twice, for a period of 20 seconds. We used disposible needles (0.3 x 30 mm, Huan Qiu, Suzhou, China).

RESULTS

Figure 3 shows the influence of acupuncture on NIRS parameters at the beginning (Fig. 3a, 21.10.) and the end (Fig. 3b, 16.12.) of acupuncture treatment. An obvious decrease in O2Hb, cHb and TOI took place during the first measurement. The trend of TOI was reproducible in the first three measurements. Thereafter, this effect was reversed (see Fig. 4a) whereby TOI und O2Hb increased during acupuncture in all of the following treatment sessions (compare Fig. 3b). The changes in mean blood flow velocity (vm) in the middle cerebral artery during the single acupuncture sessions are shown in Figure 4b and mean arterial blood pressure (MAP) in Figure 4c.

Figure 3

Fig. 3: Trend of near infrared spectroscopic data during the first (a) and the seventh (b) acupuncture session using the acupuncture scheme shown in Fig. 2

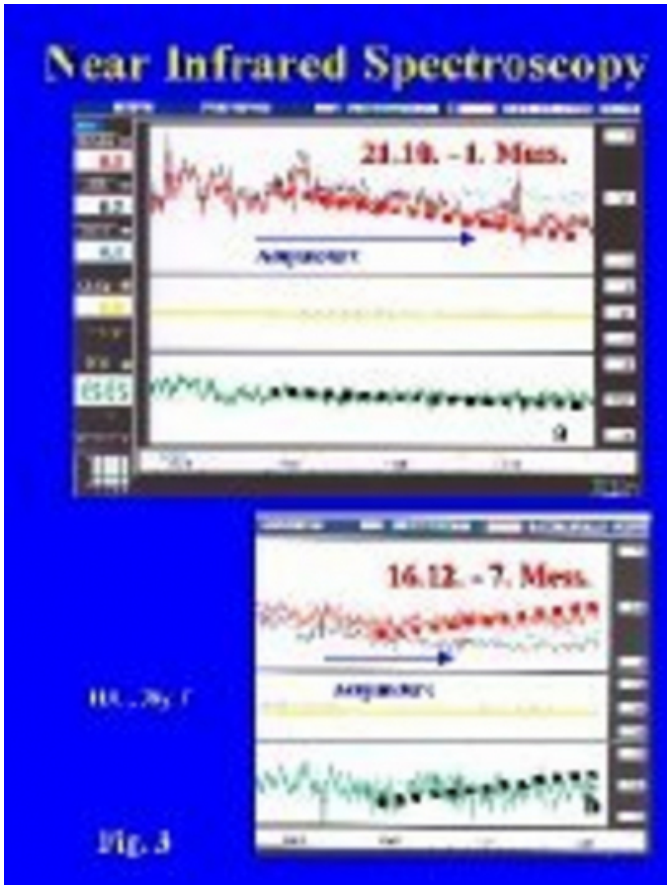
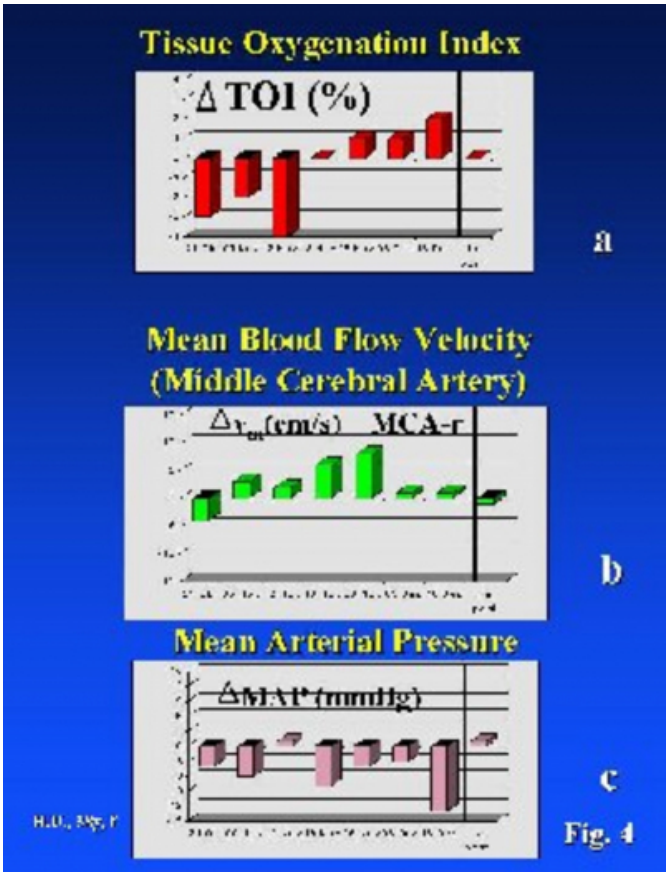


Figure 4

Fig. 4: Changes in Tissue Oxygenation Index TOI (a), mean flow velocity (vm) in the right middle cerebral artery (b) and mean arterial blood pressure MAP (c) during the individual acupuncture sessions in the 38-year-old patient



An increase in mean flow velocity in the middle cerebral artery was seen in 6 of 8 measurem ents and a simultaneous decrease in mean arterial blood pressure in 6 of 8 measurements.

The last measurement values (1a post in Fig. 4) indicate the measurement after one year.

The increases in the blood flow velocity in the MCA were accentuated by stimulating the needles (see Fig. 1).

DISCUSSION

There are essentially two hypothesis regarding the pathophysiology of migraines headaches. According to the vascular hypothesis neurologic dysfunction, vegetative irritability (aura) and vasodilatation during the headache phase are due to primary cortical malperfusion[1]. According to the neurogenic hypothesis, headache is caused by depolarization of neurons in specific areas of the cortex or brainstem, where malperfusion develops after an excitation

impuls24.

Changes in the cerebral circulation and alterations in perfusion were investigated in numerous SPECT and PET studies. Many studies showed increased values in circulation in the brainstem and mid-brain during migraine attacks.

Allthough acupuncture is widely used to treating migraines[22], there are only few methodically acceptable studies. Generally, the frequency of migraine attacks decreases for a period of 3 to 6 months. Uncontrolled clinical studies have reported success rates of 50 % – 90 % regarding headaches reduction but with control groups, studies showed success rates of 40 % – 65 %[24].

Several modalities have been used to study treatments for migraine headaches. Serum catecholamine levels have been measured. Transcranial Doppler sonography and Contingent Negative Variation (CNV)[21] have been used to evaluate neurovascular situations. These changes in slow cortical potentials are also subject to specific alterations during symptom-free intervals in migraine patients and can be seen on the EEG.

Although some authors are skeptical that the old Chinese healing method of acupuncture can be proven scientifically, we have demonstrated general and specific effects of acupuncture in the brain with newly developed and modified monitoring methods [5,6,7,8,9,10,11,12,13,14,15,16,17,18].

Because the cause of migraines may lie in a disturbed interaction among central nervous system, vasoactive neurotransmitters and cranial vessels, and because many authors characterize migraines as cortical hyperactivity [3,23], near infrared spectroscopy, in addition to other established technical methods could provide objective information.

At the present stage in the development of the technology, absolute values of cerebral oxymetry seem to require cautious interpretation. Our experience in different areas (operating room, intensive care unit, hyperbaric chamber, acupuncture) indicates that dynamic alterations can reflect considerable changes in cerebral oxygenation[4].

The present study found a significant decrease in TOI during the first three acupuncture sessions and no change in TOI during the fourth acupuncture session. In conclusion, reversal in behavior regarding frontally measured cerebral oxygenation took place after the fifth acupuncture session. In the three following sessions, an increase in TOI and a simultanous increase in O2Hb and decrease in HHb occurred during acupuncture. During the single acupuncture sessions, with the exception of the first and control measurement one year later, TCD showed an increase in blood flow velocity with a slight, simultaneous decrease in mean arterial blood pressure.

After the series of 7 acupuncture sessions, the patient was clinically free of symptoms for 6 months, and had isolated migraine attacks thereafter.

Allthough the individual range of effectivity regarding acupuncture in the treatment of migraines seems to be quite variable, our goal is to evaluate objective, reproducible data, in order to determine and register the possible effects of acupuncture regarding this widespread illness based on scientific criteria. This will require a study with a large patient collective with similar clinical symptoms.

ACKNOWLEDGEMENTS

This study was supported by the Austrian Ministry of Transportation, Innovation and Technology (GZ 140.578/3-V/A/6/99).

References

1. Cutrer FM, Sorensen AG, Weisskoff RM, Ostergaard L, Sanchez del Rio M, Lee EJ, Rosen BR, Moskowitz MA. Perfusion-weighted imaging defects during spontaneous migrainous aura. Ann Neurol 1998;43:25-31.
2. Dowsen DI, Lewith GT, Machin D. The effects of acupuncture versus plazebo in the treatment of headache. Pain 1985;21: 35.
3. Kropp P, Gerber WD. Contingent negative variation during migraine attack and interval: evidence for normalization of slow cortical potentials during the attack. Cephalalgia 1995;15:123-8.
4. Litscher G, Schwarz G. (Eds) Transcranial cerebral oximetry. Lengerich Berlin D□orf: Pabst Science Publishers; 1997.
5. Litscher G, Cho ZH. (Eds) Computer Controlled Acupuncture(r) (CCA□ Lengerich Berlin Rom Riga Wien Zagreb: Pabst Science Publishers; 2000.
6. Litscher G, Schwarz G, Sandner-Kiesling A. Computerkontrollierte Akupunktur(r). Akupunktur Theorie und Praxis 1998;26(3):133-42.
7. Litscher G, Schwarz G, Sandner-Kiesling A, Hadolt I. Transkranielle Doppler-Sonographie - Robotergesteuerte Sonden zur Quantifizierung des Einflusses der Akupunktur. Biomed Technik 1997;42:116-22.
8. Litscher G, Schwarz G, Sandner-Kiesling A, Hadolt I. Robotic transcranial Doppler sonography probes and acupuncture. Intern J Neurosci 1998;95:1-15.
9. Litscher G, Schwarz G, Sandner-Kiesling A, Hadolt I, Eger E. Effects of acupuncuture on the oxygenation of cerebral tissue. Neurol Res 1998;20(1):28-32.
10. Litscher G, Schwarz G, Sandner-Kiesling A, Hadolt I, Eger E, Lenhard H. Transcranial near infrared spectroscopy and transcranial Doppler sonography during acupuncture. In: Litscher G, Schwarz G. (Eds) Transcranial cerebral

oximetry. Lengerich Berlin D□orf Riga Scottsdale Wien Zagreb: Pabst Science Publishers; 1997;184-198.
11. Litscher G, Wang L. Visualisierung von peripheren Durchblutungs□erungen w□end der Akupunktur mittels Thermographie. Biomed Technik 1999;44:129-34.
12. Litscher G, Wang L, Lehmann R. Computerkontrollierte Akupunktur□- Einflu□der K□rakupunktur auf die Blutflu□eschwindigkeit von intra- und extrakraniellen Arterien. Europ Z Akup, Der Akupunkturarzt/Aurikulotherapeut 2000;1: 4-19.
13. Litscher G, Wang L, Wiesner-Zechmeister M. Specific effects of laserpuncture on the cerebral circulation. Lasers Med Sci 2000;15:57-62.
14. Litscher G, Wang L, Yang NH, Schwarz G. Computer-controlled acupuncture□ Quantification and separation of specific effects. Neurol Res 1999;21: 530-4.
15. Litscher G, Wang L, Yang NH, Schwarz G. Ultrasound-monitored effects of acupuncture on brain and eye. Neurol Res 1999;21:373-7.
16. Litscher G, Yang NH, Schwarz G, Wang L. Computerkontrollierte Akupunktur(r): Eine neue Konstruktion zur simultanen und kontinuierlichen Erfassung der Blutflu□eschwindigkeit in der A. supratrochlearis und A. cerebri media. Biomed Technik 1999;44:58-63.
17. Litscher G, Yang NH, Wang L. Ultrasound-controlled acupuncture. Internet J Anesthesiology 1998;2/4, http://www.ispub.com/journals/IJA/Vol2N4/acu.htm
18. Litscher G, Yang NH, Wang L, Schwarz G. Quantitative Separation spezifischer Akupunktureffekte von Gehirn und Auge mittels bidirektionaler Ultraschallme□onstruktion. AKU 1998;26(4):212-7.
19. Siebenthal K, Bernert G, Casaer P. Near infrared spectroscopy in newborn infants. Brain Dev 1992;14:135-143.
20. Stewart WF, Lipton RB, Celentano DD, Reed ML. Prevalence of migraine headache in the United States. Relation to age, income, race and other sociodemographic factors. JAMA 1992;267:64-9.
21. Walter WG, Cooper R, Aldrige VJ, McCallum WC. Contingent negative variation: An electrical sign of sensorimotor association and expectancy in the human brain. Nature 1964;203:380-4.
22. Weinsch□. Akupunktur bei Kopfschmerzen. Methodische Grundlagen der Ergebnisse klinischer Untersuchungen. Der Schmerz 1996;10:149-55.
23. Weinsch□, Johnsen S, Niederberger U, Kropp P. Akupunktur in der Migr□therapie. In: Maric-Oehler W, H□K. (Eds) Akupunktur und Universit□ Bestandsaufnahme und Perspektiven. 1. Mainzer Akupunktur-Symposium. Stuttgart: Hippokrates; 1997;52-64.
24. Wessely P, Klingler D. Therapie ausgew□ter Kopfschmerzformen. Konsensus-Statement. Intern Z òztliche Fortbildung 1998;19:5-27.

Author Information

Gerhard Litscher, Ph.D.
Biomedical Engineering, Department of Anesthesiology and Critical Care, University of Graz

Lu Wang, M.D.
Biomedical Engineering, Department of Anesthesiology and Critical Care, University of Graz

Gerald Niederwieser, M.D.
Department of Neurology, Barmherzigen Br□ospital Graz-Eggenberg