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“Needles of Light”: A New Therapeutic Approach

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ABSTRACT

A new therapy with laser needles was introduced into medical acupuncture in 2001. It is a pain-free procedure with practically no side effects, according to Traditional Chinese Acupuncture. Laser needles can be used on multiple acupuncture points with high-power density, simultaneously on body, skull, or ear, thus stimulating these points. The needle equivalence has been demonstrated in clinical as well as in basic research with the help of “neuromonitoring” of the central nervous system. In many patients, therapy with laser needles can produce long-term healing effects in various illnesses. In this paper, the basic theoretical principles, practical procedure, and new equipment are discussed. Recently, we have shown that by using different wavelengths and intensities, an improvement of point stimulation and increase of penetration depth of the system can be achieved. Results of basic science research and the clinical results of more than 8,000 cases in all treatment fields are summarized. In addition, the clinical results of more than 25,000 treatments are summarized and the scientific basic research studies are introduced. A comparison of our data with the recently published German Acupuncture Trial (Gerac Study) showed similar effects.

Key Words: Laser Needle, Power Density, Penetration Depth, Simultaneous Laser Acupuncture, Biological Effects, Laser Needle Body and Mouth Shower, Double-Blind Studies, Gerac Study

INTRODUCTION

AS ACUPUNCTURISTS, WE SOUGHT TO develop acupuncture treatments free from pain and side effects by using laser technology and at the same time, create a scientifically verifiable equivalence to classical metal needles. Concurrently, the new technology should allow one to perform an individually aligned point program, according to Traditional Chinese Medicine (TCM) guidelines, by simultaneous treatments.

The laser principle with high-energy bundled beams is ideal for performing a therapy free from pain and side effects. Laser acupuncture has existed for more than 20 years, but needle equivalence and simultaneous treatment were previously unknown. Perhaps the classical laser acupuncture should preferably be called “laser pen treatment” because this method only includes treating single points sub-

sequently and not simultaneously. Additionally, punctual energy outputs render an effective in-depth stimulation of the acupuncture point improbable, or that can only be realized via reflex mechanisms.

In addition, the recommended short needling periods of 1-minute raise the question of clinical effectiveness. It is not without cause that this type of acupuncture treatment is recommended for children due to their thinner skin layers.

Much literature exists on the subject of laser acupuncture.¹⁻⁶ All such works include the following thesis: a laser output exceeding a specific threshold would block the desired effects and, thus, finally achieve the opposite effect or even damage the acupuncture points through the high-energy light. Such hypothesizing has not supported laser acupuncture and has perhaps hindered any further development. This has resulted in disillusionment regarding a previously promising method.

Due to a lack of scientific evidence, laser acupuncture devices of any kind have been rejected by the US Food and Drug Administration. Many scientists refuse to consider this method as a genuine acupuncture method due to the single-point treatment described above. Even efforts to prove the effects resulting from laser pen treatment by neuromonitoring of the central nervous system remain unsatisfactory.

The solution could perhaps consist of so-called laser needles, which should lead to a simultaneous stimulation with measurable energy supply and measurable results. To this end, the “needles” represent the ends of light-conducting fibers that transport the beam generated in the laser diodes to the body, and introduce them by means of direct contact. In this context, the term needle must not be confused, because this *needle* is not punctured into the body. It is only the extremely focused beam that penetrates the body *like a needle* to ensure an adequate acupuncture stimulation. Thus, the term *laser needle acupuncture* was born.

After 4 years of development, the first laser needle system was presented at a conference in Germany in 2000. This first fiber-optic device enabled the simultaneous treatment of 8 points with 50-mW red light lasers, with a wavelength of 680 nm, by means of plastic fibers attached to the skin. This first system operated time-controlled, with a continuously irradiating laser source without the use of frequencies and output control.

We performed an extensive observational study including multiple clinical syndromes with a focus on chronic pain disorders, which enabled the new device's verification. The collected data resulted in the first publications about the new laser needles.^{7,8}

Numerous introductions of the new system followed, with scientific presentations of the treatment data at various national and international conventions and seminars, followed by increasing interest in professional circles.^{9,10} Simultaneously, extensive clinical and scientific studies were initiated, on which further information is provided below.

SCIENTIFIC BASICS: TERMS CONCERNING LASER PHYSICS

Unlike the diffuse light of a light bulb, laser light is characterized by an extremely narrowly-defined wavelength range (monochromasie) and the parallel phase flow of the lightwaves (coherence). A difference exists between continuously irradiating laser sources (continuous wave) and pulsed irradiating lasers with varying frequencies (pulse wave).

In addition to the wavelength (indicated in nanometers) and the frequency (indicated in Hertz), the output (in Watts) and the supplied energy (in Joules) are measured.

The applied power per surface, the power density in W/cm^2 , and the related energy density are the decisive parameters for stimulating a small area, e.g., an acupuncture point.

The Importance of Power Density

Figure 1 shows how much the applied laser energy per area depends on the output surface of the applicator tip. Comparing the diameter of the applicator tip to the power density, the exponential course of the curve quickly becomes evident. With a laser output tip diameter of 2.8 mm, a power density of $0.5 \text{ W}/\text{cm}^2$ is achieved. With a laser output tip diameter of 0.8 mm, the power density increases up to $5 \text{ W}/\text{cm}^2$. Despite this high density, physical effects on the tissue with heating and coagulation typically do not occur until at least $15\text{--}20 \text{ W}/\text{cm}^2$. Thus, applying a laser needle with an output opening of only 0.5 mm can increase significantly the energy performance on the point.

Therefore, the therapeutic effect does not depend only on the energy of the applied laser diode, but also on the wavelength of the light, the output per surface (W/cm^2). This output can be substantially higher when using a laser with lower output and a small applicator surface vs using a significantly stronger laser with a larger applicator surface, or eventually missing direct skin contact.

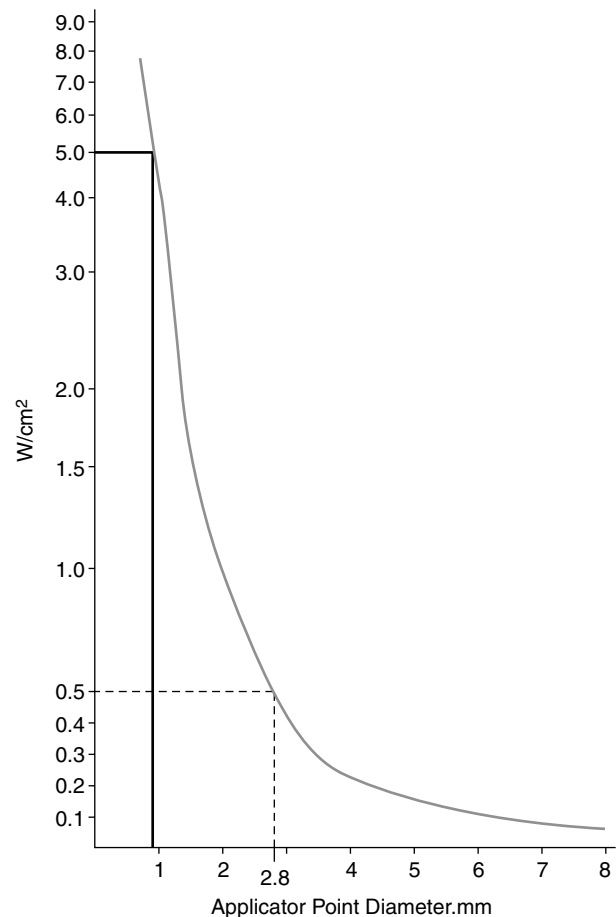


FIG. 1. Dependence of applied laser energy per area on the acupuncture point from the diameter of the applicator tip.

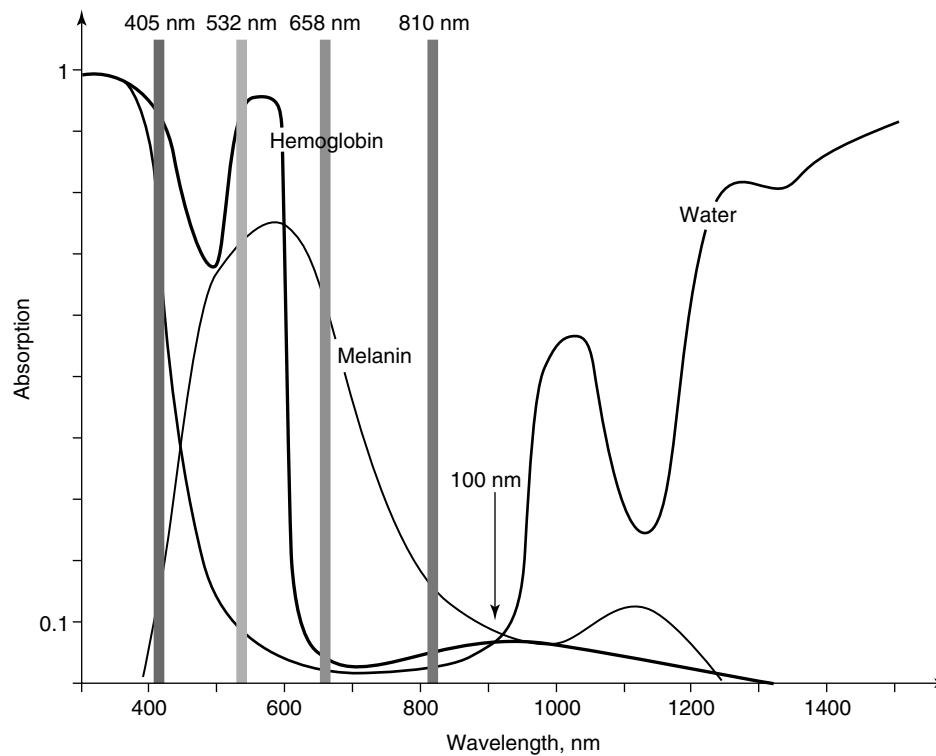


FIG. 2. Absorption of different wavelengths in biological tissue.

Changes of the Laser Beam in Tissues

A laser penetrating biological tissue triggers refraction, impact, and diffusion effects of the penetrating photons. Therefore, metal and laser needles can only be compared to a limited extent. The diffusion of light particles leads to a kind of photon fog that causes an enlargement of the beam in the tissue, thus limiting the penetration depth. Additional absorption phenomena occur in the tissue; on the one hand, unspecified through pigments, and on the other hand, specifically at triggering biological effects. Such limiting phenomena can be pronounced to a lesser extent; the smaller is the above-mentioned applicator surface of the laser needle applied directly to the skin.

How can these disturbing effects be minimized and positive effects be maximized? Reflection effects can be minimized by applying the laser needle directly to the skin, while using a smaller applicator surface that will reduce diffusion. The unspecified absorption of the laser light in the tissue can be reduced by slightly pressing the needle into the skin to displace the tissue fluid with a minimum absorption through typical skin pigments.

Which Wavelengths Should Be Used?

Consideration concerning the optimum wavelength is based on the absorption behavior of the tissues with regard to laser light with various wavelengths (Figure 2).¹¹ There

is a reputed therapeutical gap in the tissue's absorption spectrum between 650 nm and 900 nm in the red and infrared range, in which the absorption is minimized and a maximum tissue penetration depth can be expected. (This is why, e.g., green lasers, in the range of 500 nm with a low penetration depth, are suitable only for ear acupuncture or other superficial points.)

Which Penetration Depths Can Be Expected?

This question is difficult to answer; in addition to the applied wavelength and the power density described above, various other parameters such as tissue pigments and turgor must be considered. A well-focused laser beam in the red light range cannot exceed a penetration depth of approxi-

TABLE 1. DIMINUTION OF 500-mW GREEN, RED, AND INFRARED LASERS IN BIOLOGICAL TISSUE

	500-mW Laser at output, by depth	
	1 mm	6 mm
Green	0.5 mW	0.0001 mW
Red	50 mW	0.0005 mW
Infrared	250 mW	8 mW

mately 1–2 cm, but may reach 5 to 10 cm in the infrared range.¹¹ Therefore, “penetration depth” must be defined in a different way as for a pricked needle: the diffusion phenomena described above leads naturally to a successive diminution of the beam. It is important to define at which degree of diminution a therapeutic effect could still be expected.

Manufacturers of mere red light laser devices could also argue that by supposed inductive and snowball effects, even at this wavelength, photons can reach a depth of 10 cm. It is doubtful in this case that some single photons would still generate the desired therapeutic effects by stimulating the acupuncture point.

Especially in patients with dark skin, no real effect can be expected when only red lasers are used because of high absorption of skin melanin.



FIG. 3. Modern fiber-optic laser needle device with 12 channels for treating up to 12 acupuncture points simultaneously with different wavelengths.

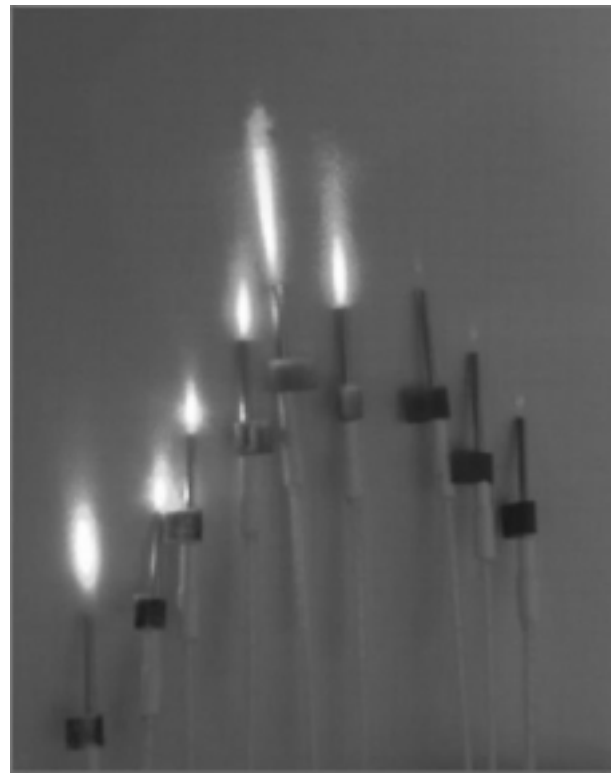


FIG. 4. Green, red, and infrared laser needles coming out of the end of a glass fiber.

The term “half penetration depth” indicates the depth at which half of the laser light is absorbed.

Provided that the absorption of an individual light quantum per cell is considered as the minimum output, a maximum seems possible of 4 mm for green light, 1 cm for red light, and 4–10 cm for infrared light, with the half-penetration depths as specified above (Table 1).

Biological Effects of Laser Light

General reactions in tissue include decongestion, alleviation of pain, improved bloodflow, immune stimulation, and reparation of tissue.

Reactions on the Cellular Level

The following effects may occur: increase of ATP synthesis, stimulation of the antioxidative metabolism, formation of singlet oxygen, stimulation of the mitochondrial metabolism, increase of protein biosynthesis, and increase of DNA synthesis and cell renewal.

Further Development of Laser Needle Technology

In the context of an extensive double-blind study concerning disturbances of the lumbar spine, a clearly limited effect of the red light laser on the deep tissue, especially on

deeper points of the Bladder and Gallbladder Meridians, became evident (Weber M, Ruth M, Zenz M; Investigation of the effectiveness of laser acupuncture with laser-needles in chronic low back pain; unpublished data, 2007). This fact led to a new patented system.¹²

The new system offers the following designs:

- Basic device as a pure control device with 12 channels, enabling the simultaneous treatment of up to 12 points (Figure 3).
- Outsourcing of laser modules (diodes with drivers and fiber connection), enabling the replacement of laser modules and combination of various wavelengths.
- Combination of 6 channels of red at 658 nm, with 50 mW with 6 channels of infrared at 810 nm and 100 mW with 40 mW of red and 80 mW of infrared, at the fiber's end during skin contact (loss at optical interfaces, maximum 20%).
- Stimulation of superficial points with green and red light, and deeper points with infrared light (Figure 4).

- Flexible adjustment of laser output from 0% to 100%, e.g., for the treatment of extremely sensitive areas (face).
- Continuous operation (continuous wave) and frequency operation (pulse wave) is enabled with frequencies, according to Bahr, Nogier, and Reininger, as well as free frequencies.

PRACTICAL WORK WITH LASER NEEDLES

How High Are the Applied Energies? Can Potential Side Effects Occur?

The overall doses of the applied energy per point are within a range of 20–30 Joules. In this range, no tissue damage is expected. When considering certain basic rules that resemble the principles of classical acupuncture, no side effects are to be expected and have not occurred in thousands of treatments (in our experience).



FIG. 5. Body acupuncture of a typical shoulder syndrome.

Does the Patient Feel the Treatment?

Sometimes, a slight De Qi feeling occurs after 2-10 minutes of treatment if enough photon energy for stimulating the point has penetrated the tissue.

How Are Treatment Periods Determined?

As described above, the recommended treatment times differ substantially from the treatment times of conventional laser pen acupuncture, for which therapies are completed within seconds or minutes.

The criterion of De Qi generally is regarded as an optimum achievement of the point with the utmost effect, and in this case, it was also used as a basis. De Qi in laser needle acupuncture occurred in an average of 10 minutes; thus, a beginning optimum point stimulation could be assumed, and the therapy was extended to 20 minutes. Extensive tests over years have repeatedly shown that the most effective therapy has been obtained in this time period. The treatment time has been reduced to 10 minutes for sensitive areas such as the face and ear, but, can be extended gradually up to 15–20 minutes.

AREAS OF APPLICATION

Body Acupuncture

How are the laser needles attached to the body? We initially developed the following method and applied it for several years: a small silicone sleeve with a plate, covered by a perforated plaster, is pushed on the laser needle and sub-

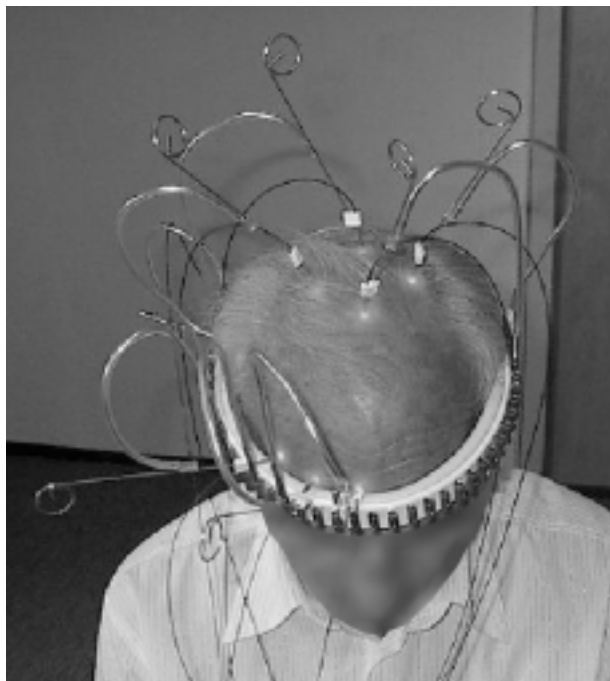


FIG. 6. Skull acupuncture with red laser needles in a patient with cerebral insufficiency.

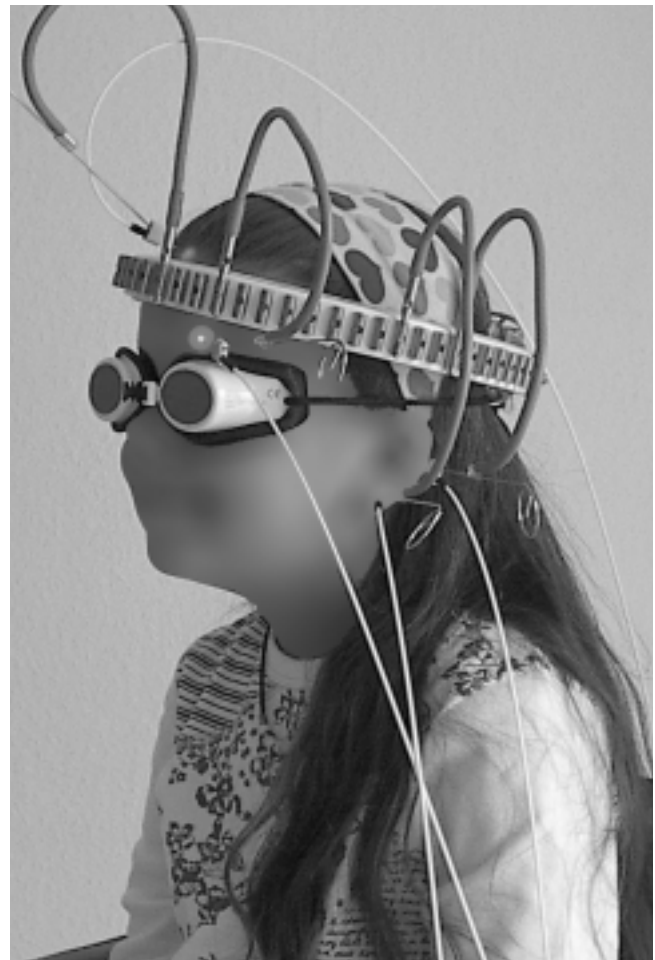


FIG. 7. Ear and skull acupuncture with red laser needles in a child with migraine.

sequently fixed on the skin (Figure 5). (This procedure is simple but can result in a hygiene problem in case of frequent reuse of the sleeves.)

Two new methods have been developed: (1) laser needles are fixed with industrial-made disposable sleeves that are equally attached with a perforated plaster, or (2) laser needles are attached by means of a self-clamping (with the ability to be sterilized) stainless steel sleeve and a perforated plaster.

Acupuncture of the Ears and Head

An adjustable padded head ring is placed on the head like a crown (Figure 6). Up to 12 flexible coated wires carry the laser needles, which can be attached to the point with the help of a guiding bar, with slight pressure and without glue (Figures 7-9).¹³

BASIC RESEARCH

Most of the basic research on laser needle therapy has been performed by Professor Litscher (Karl Franzens, Uni-



FIG. 8. Ear acupuncture with green laser needles in a child with allergy.

versity of Graz, Austria) by means of various neuromonitoring procedures. To this end, various procedures such as measuring the speed of the blood flow in different brain arteries with pulsed-Doppler examination, the determination of the arterial oxygen saturation, as well as the metabolic activity in various areas of the brain by using cerebral magnetic resonance imaging (MRI), have been applied.^{14,15}

In 2002, Litscher proved for the first time an effect of laser needles on the blood flow rate in the ophthalmic artery using the pulsed-Doppler method. In this context, an effect of at least 50% as compared with classical needle acupuncture could be verified.¹⁶

A study concerning the oxygen saturation in hemoglobin in various areas of the brain showed that laser needles achieved virtually the same effect as needle acupuncture. The previously postulated term “needle equivalence” could now be verified.¹⁷

In a double-blind study begun in early 2004, an enhanced activity of the sight and smelling region under laser needle therapy was demonstrated.¹⁸ Similar results were demonstrated in a placebo-controlled double-blind study by Siedentopf et al at the University of Innsbruck, Austria.¹⁹

A summary of the various works about laser needles can be found in the first book about laser needle acupuncture, republished in 2004.²⁰

CLINICAL STUDIES

The authors performed approximately 25,000 treatments with laser needles at our institution between 2001 and 2006 (Table 2). In this context, about 15,000 treatments were performed for orthopedic syndromes. The remaining treatments concerned various other areas such as neurological, internal, otolaryngologic, and gynecological disorders. The overwhelming majority of treatments were for orthopedic pain syndromes, an inevitable reflection of a general medical practice.

Therapy evaluations in the beginning were established in the frame of an extensive observational study. The first treatments served as proof of the general effects of the laser-needle therapy and for comparing the latter to classical acupuncture. The laser needles soon demonstrated a positive effect similar to that achieved with classical needles.

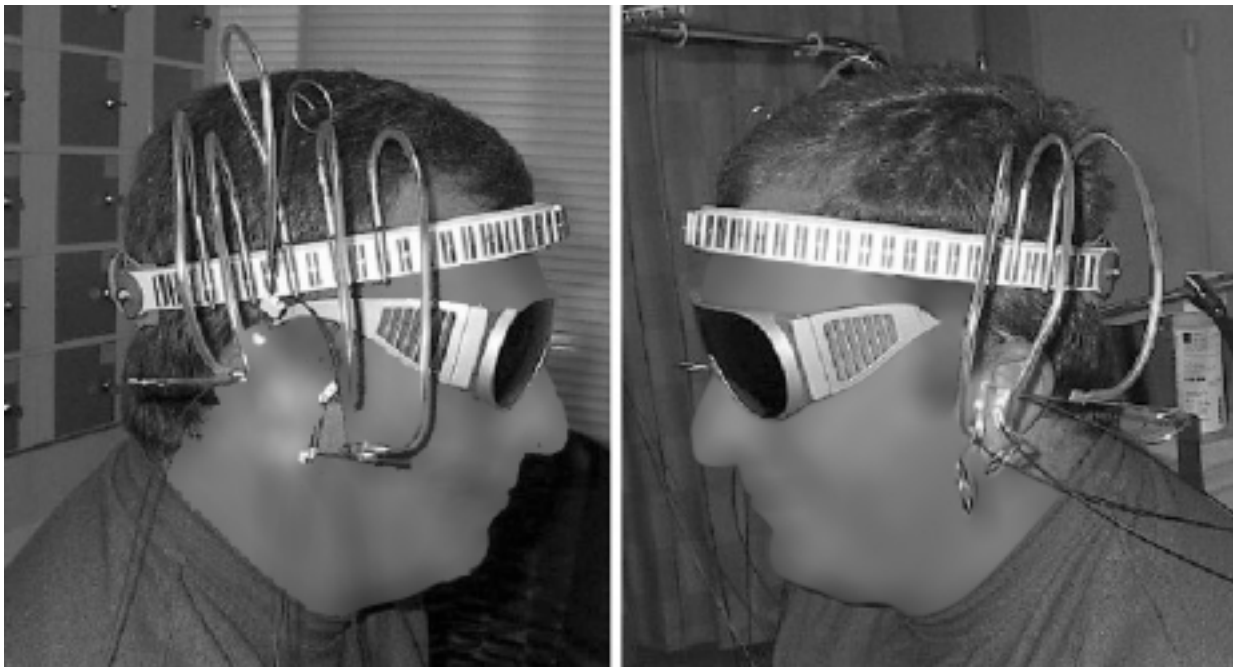


FIG. 9. Ear acupuncture with red laser needles in smoking addiction.

The first developed laser-needle system (8 needles only, red light at 680 nm) had an especially beneficial effect on structures close to the surface, such as tendinites and neuritis, or in the area of small finger joints. However, a clinical double-blind study (Weber et al, unpublished data, 2007) showed that the red light laser needles did not exceed placebo effects with regard to lumbar spine syndromes. This first disappointing result was because the penetration depth of red laser light is not high enough to stimulate points in the depth of the tissue (e.g., in the Bladder Meridian). Therefore, a combination of 6 red (658 nm) and 6 infrared (810

nm) laser needles were used in a new advanced laser-needle system as described above, and significantly better results were achieved with regard to the described syndromes.

In Germany (2001-2006), the world's largest acupuncture study was undertaken. This study, the German Acupuncture Trial (Gerac-study), initiated by the government and health insurance companies, examined 2,201 patients with low back pain, gonarthrosis, and headache/migraine. Patients were randomly assigned to treatment with TCM needle acupuncture, sham acupuncture, or a conventional therapy. Additionally, a cohort study with 367,646 patients was per-

TABLE 2. OVERVIEW OF TREATMENT DATA, 2001–2006*

<i>Orthopedics</i>	<i>Neurology/Psychology</i>	<i>Internal Medicine</i>
Gonarthrosis (<i>n</i> = 425)	Migraine and other headache syndromes (<i>n</i> = 343)	Allergic diseases (<i>n</i> = 76)
Spinal column syndromes (<i>n</i> = 405)	Psychovegetative fatigue (<i>n</i> = 98)	Gastrointestinal disorders (<i>n</i> = 65)
Tennis elbow (<i>n</i> = 144)	Depressions (<i>n</i> = 95)	Disorders in peripheral circulation (<i>n</i> = 49)
Coxarthrosis (<i>n</i> = 135)	Tinnitus (<i>n</i> = 81)	Bronchial asthma (<i>n</i> = 44)
Shoulder syndromes (<i>n</i> = 127)	Toxicomania (smoking, drugs) (<i>n</i> = 80)	
Morbus Bechterew and polyarthritis (<i>n</i> = 88)	Residual paresis after stroke (<i>n</i> = 77)	
Tendinitis (<i>n</i> = 88)	Trigeminal neuralgia (<i>n</i> = 29)	
Rhizarthrosis (<i>n</i> = 48)		
Fibromyalgia (<i>n</i> = 28)		

*Patients receiving ≥ 10 treatments.

TABLE 3. ORTHOPEDIC PATIENTS RECEIVING ACUPUNCTURE ($N = 1,500$)*

	<i>Mean (SD) Visual Analog Scale Score</i>			
	<i>Knee</i> ($n = 50$)	<i>Low Back Pain</i> ($n = 50$)	<i>Shoulder</i> ($n = 50$)	<i>Headache/Migraine</i> ($n = 50$)
Baseline	6.7 (1.9)	6.6 (2.1)	6.3 (2.2)	7.3 (2.5)
3 Months	3.6 (2.5)	3.3 (2.6)	4.0 (2.4)	3.5 (2.7)
6 Months	3.8 (2.3)	3.5 (2.7)	4.1 (2.6)	3.4 (2.8)

*Significant differences were found between baseline and 3-6 months after treatment ($P < .01$ by t test), but not between the third and sixth months.

formed to prove the efficacy of acupuncture in general medical practice. In this study, low back pain, arthrosis of knee and hip joint, headache, and migraine were included as well. The authors' patients took part in these studies, and 1,395 patients were treated with needle acupuncture, using the protocol of the Gerac-study.

Results of the Gerac-study, recently published in January 2007,^{21,22} showed that acupuncture was superior to conventional treatment in low back pain and gonarthrosis patients, even up to 6 months later. Consequently, acupuncture treatments for these indications are now accepted and reimbursed by health insurance companies starting in January 2007. (Treatment of migraine with acupuncture was considered successful, but not significantly better than conventional therapy. Thus, acupuncture for this indication is not supported as yet by insurance companies.)

To compare laser needle acupuncture with metal needle acupuncture, we chose random samples from our orthopedic patients only treated with laser needles ($n = 1,500$). Fifty patients each with knee, shoulder, low back pain, and headache/migraine were included. The results are shown in Table 3 and Figure 10.

We determined that there were no significant differences in our results when comparing them with those of the Gerac-study. Only the results of migraine treatment seemed to be better than in the Gerac-study. Our results were further proof

that laser-needle acupuncture could be therapeutically equivalent to classical needle acupuncture. The above-mentioned studies on healthy volunteers by Litscher and Siedentopf¹⁹ were confirmed by treatment of our patients.

Further advantages of laser-needle acupuncture over classical metal needle acupuncture have been demonstrated. Apart from 2 cases of near-collapse in about 25,000 treatments with laser-needle acupuncture, there were no cases of pneumothorax, erysipelas, intra-articular knee infection, or dangerous collapse as documented in the Gerac-study as potential side effects of needle acupuncture. Because of the painless laser light, this method is more accepted by most of the patients. Therefore, a wider patient group may benefit from laser-needle therapy (i.e., children, patients taking coumadin, pain-sensitive patients, etc). Perhaps the most beneficial effects of the laser needle are the additional biological effects of laser light, which have been investigated and documented in numerous publications, for suppression of inflammation, tissue repairing and regeneration, and immunostimulative effects.

THE LASER NEEDLE BODY AND MOUTH "SHOWER"

It is possible to place 1 or more laser needles together in a special grouping that resembles the head of a normal wa-

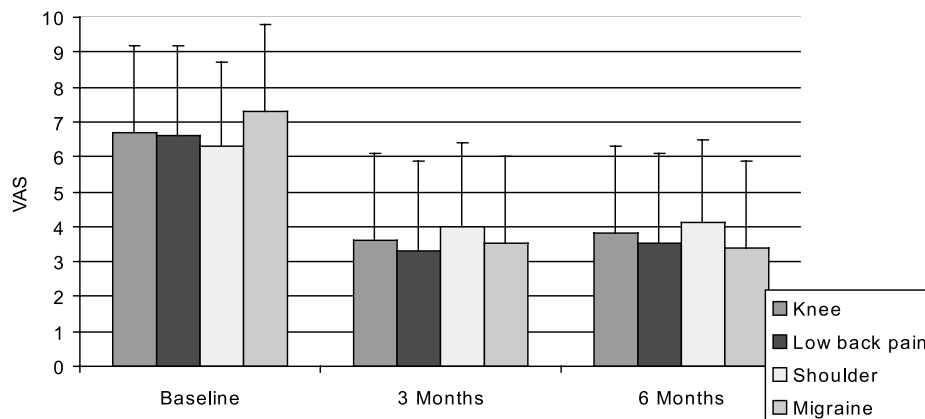


FIG. 10. Pain relief after treatment of 4 different pain syndromes 3-6 months later. VAS indicates visual analog scale.



FIG. 11. The laser needle body “shower” for treatment of low back pain.

ter shower. In this “shower,” up to 12 needles with different wavelengths can be applied (Figure 11) to reach different penetration depths and different biological effects on the tissue. With this method, a high-power acupuncture area can be treated with excellent results. This method can also be used for dermatological treatments (e.g., eczema, neurodermatitis, acne, chronic wounds).

Laser needles can be applied alternatively in a special “mouth shower,” resembling a toothbrush, for treating different diseases of the inner mouth and teeth (tooth decay, gingival diseases, pyorrhea, etc) (Figure 12). Mouth acupuncture can be performed by this method also. Blue laser needles can be used in this field because of their bactericidal effects.

DISCUSSION

Laser-needle acupuncture can be a potential alternative to classical needle acupuncture, including the advantages of stimulation at multiple points, simultaneously without trauma, pain, or side effects. The positive results of the first studies could be reproduced and extended several times.^{20,23}

Laser-needle acupuncture is an innovative therapeutical instrument that allows simultaneous treatment of multiple points according to TCM rules. The limited penetrations of laser needles and lack of pain lead to high acceptance by patients. Basic research and clinical studies have already demonstrated impressive evidence for this method. Therefore, the “needles of light” not only extend the therapeutic range of the acupuncture physician, but can, by means of double-blind studies, also open up the complex topic of acupuncture research.

CONCLUSIONS

Our hope is that laser-needle acupuncture will achieve the same status as classical acupuncture. The call for scientific



FIG. 12. The laser needle “mouth shower.”

efficacy of acupuncture has become louder in recent years. Medical science calls for double-blind studies. Laser-needle acupuncture is ideal for performing such studies, enabling a significant increase in soundly designed research in this area. This may serve to redefine the importance of acupuncture. We look forward to our many colleagues' contributions to the development of the laser needle acupuncture with their own studies.

ACKNOWLEDGEMENT

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