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Laserneedle Acupuncture: A Critical Review and Recent Results

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ABSTRACT

In the last 5 years, laserneedle acupuncture has become a new category in acupuncture, with its own scientific basics. It combines the tradition of Chinese acupuncture with the possibilities of modern technology. Laserneedle acupuncture is in accordance with the aim of traditional medicine because it uses the most essential and most natural medium of our existence, the light, to heal illnesses. The painless laserneedle acupuncture is of proven medical effectiveness and particularly suited for the treatment of children and those patients who regard the metal needle insertion into the skin as unpleasant. In daily practical use, laserneedle acupuncture can be performed like any traditional needle acupuncture treatment. The diagnostic criteria of acupoint selection, the treatment duration, and treatment frequency are identical to the traditional Chinese acupuncture. To perform successful laserneedle acupuncture treatments, no additional qualification is required. Offering the painless laserneedle acupuncture to the patient means that the acupuncture needles are substituted and the risks of the metal needle are eliminated. Different companies offer laser devices and recently, the third generation of the original laserneedle device has become available in Europe.

Key Words: Laserneedle, Acupuncture, Laser

INTRODUCTION

The basic idea for the development of "laserneedles" for acupuncture in the Biophotonic Research Group at Paderborn University (in Germany) originated from an acupuncture analysis in Europe 10 years ago. At that time, the first hand-held devices/"laser pens" arrived on the market, which were recommended as instruments to perform painless laser acupuncture treatments. It is obvious, however, that acupuncture treatments using such devices are not in accordance with the long tradition of Chinese acupuncture which is based on a *simultaneous stimulation* of a selected acupuncture point combination. Hand-held acupuncture laser devices allow just a serial stimulation of acupuncture points, i.e., 1 point after the other. The question arises: is it acupuncture if one sticks a needle in the first acupuncture point, takes it out after 2 minutes, punctures the second point for 2 minutes, takes it out again, and stimulates the third point, and so forth. Every experienced acupuncturist would perhaps answer, "No, that is not acupuncture. I would never do that. The needles must remain for at least 20 minutes in the selected acupuncture points." That is, the points have to be stimulated simultaneously. Our analysis came to the same conclusion; furthermore, we could not find proof in the literature of a serial point stimulation approach, neither for metal needles nor for laser pens.

With the development of laserneedles, we have tried to preserve the methodical rules of the classic Chinese acupuncture. Several fundamental scientific and medical problems had to be resolved and investigated:

1) How can visible laser light stimulate acupuncture points? It is known from daily experience that visible light

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that is shining on the skin does not create any acupuncture-like reaction nor does it interact with peripheral sensory nerves. The pleasant warmth that we feel on the skin during a summer day does not come from the visible light of the sun. How can laser light stimulate acupoints? If one pricks a metal needle in the skin, the patient often feels pain. Is that physical stimulation an essential requirement for efficient acupuncture?

2) Which parameter and properties are important in laser acupuncture that determine the therapeutic efficacy?

3) Is it dangerous to stimulate acupuncture points by laser irradiation? Are there any risks or side effects?

4) Is laser acupuncture comparable to the traditional metal needle acupuncture regarding its therapeutic efficacy?

5) What are the limits and challenges of laserneedle stimulation.

These 5 topics are addressed in this paper. One of the practical outcomes of our previous research work was a new medical instrument, the "laserneedle."[1] We are aware that the term laserneedle is somewhat misleading; it suggests that these instruments hurt the skin. This is not true; laserneedles are non-invasive instruments that do not puncture the skin. They are brought in contact with the skin and can be fixed on the skin, but do not penetrate the skin. Therefore, acupuncture treatments with laserneedles are of non-invasive character and are free of the unpleasant metal needle pain sensations.

HOW DOES LASERNEEDLE ACUPUNCTURE WORK?

The mechanism of acupuncture analgesia has been studied extensively in the past 2 decades in Western countries.[2] Studies using biomedical instruments have demonstrated the key role of the brain in acupuncture.[3–11] It was also found that the insertion of a metal needle into an acupuncture point leads to a release of different chemical substances like histamine, bradykinin, substance P, and ATP in the tissue at the acupuncture point. Due to the increased concentration of these substances, the peripheral nociceptors, which exist in great numbers at acupoints, seem to become depolarized. As a consequence, rhythmic discharges occur in nociceptors and a cascade of electrical signals (action potentials) is generated and transmitted via afferent nerve fibres to the brain. Specific cortical areas like the pain-related cores of the hypothalamus and areas of the limbic system become activated.[3,12]

The central nervous system SYMBOL HERE _ -endorphins and other opiogen or non-opiogen neurotransmitters via efferent signal paths to the peripheral targets. This rather short description of basic mechanism acupuncture analgesia. That is, acupuncture effects are based on rhythmic discharges of nociceptors and are not based on the needle pain. As a consequence, painless acupuncture should be possible, provided that the rhythmic discharges of nociceptors can be induced in a non-invasive, non-traumatic way. In this context, the question arises: can we use laser irradiation for the induction of discharges in peripheral nociceptors? The answer is not as simple as it seems. Visible light does not interact with peripheral nerves; we do not feel pain during light illumination of the skin. How can nociceptors discharges be generated by light if there is no interaction? To investigate this problem, we did cell research studies, using mast cells selected from human connective tissue.[13] Single mast cells were isolated by a patch-clamp technique and illuminated with the red radiation of a laserneedle. Figure 1 demonstrates the effect of the laserneedle-radiation.

A few minutes after laserneedle illumination, the mast cell degranulates, releasing histamine. Conversly, a mast cell that is not illuminated does not show any effects under the same experimental conditions. This suggests that the irradiation of red laser light, emitted by a laserneedle, leads to a release of histamine in the connective tissue at the acupoint. When the histamine concentration increases, the nociceptors again become depolarized and rhythmic discharges may initiate. This may be the basic mechanism of laser acupuncture and it suggests the important role of connective tissue in acupuncture. The stimulation is of indirect character; the light does not directly influence the peripheral nociceptors, but probably influences indirectly the alteration of the histamine concentration in the surrounding connective tissue. We have found that the release of histamine from the connective tissue mast cells occurs only when a critical value

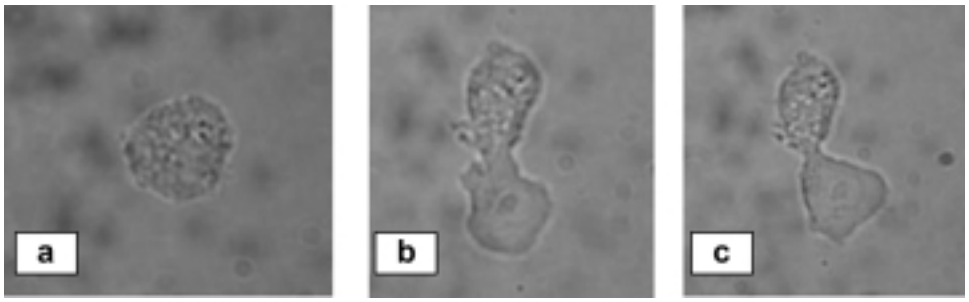

FIG. 1. Degranulation of a single human mast cell of connective tissue, irradiated 60 s by a laserneedle, in-vitro isolated by a patch-clamp technique (a: before irradiation; b: after 10 minutes; c: after 25 minutes).

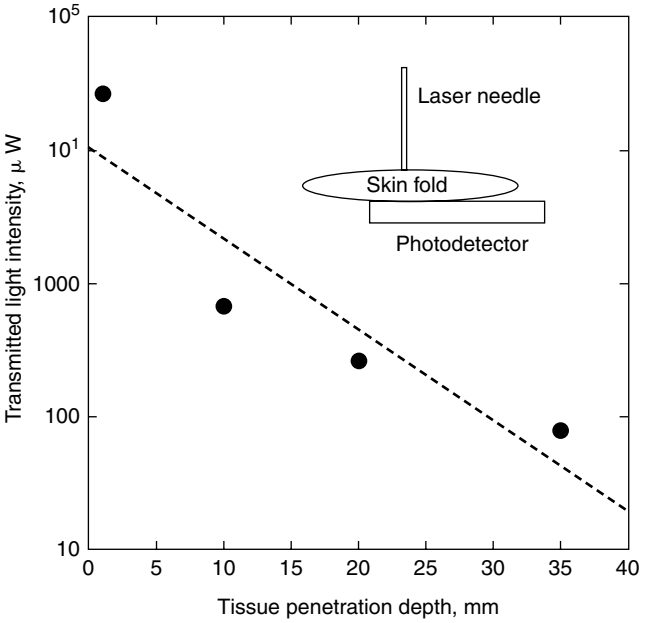

FIG. 2. Experimentally-determined tissue penetration depth of laserneedle radiation of 685 nm wavelength. The intensity of the transmitted laser radiation is reduced by 1 magnitude of order after penetration of a 35 mm skin fold. The effective penetration depth of 685 nm laserneedle radiation in human tissue, therefore, is in the order of 35 mm.

of laser irradiation (light power per area) is exceeded. The laserneedles had an irradiance of 20 W/cm^2, a value able to induce needle-equivalent acupuncture effects.[4–11] The conclusion may be that there is basically no difference in the stimulation of an acupoint by insertion of a metal needle compared to the stimulation or laser radiation. Both approaches generate the same rhythmic discharges and action potentials in peripheral nociceptors and activate analogous afferent and efferent signal transduction paths and therefore, similar acupuncture effects. Invasive needle acupuncture and non-invasive laserneedle acupuncture probably only differ in the specific way of inducing changes in the chemical composition of the connective tissue around the acupoint-nociceptors.

What Determines the Therapeutic Efficacy of Laser Acupuncture?

The most important laser acupuncture parameter is power per area of the laser beam. This parameter was optimized by our mast cell experiments. The degranulation of connective tissue mast cells requires an irradiation of about 20 W/cm^2. For laserneedles, which emit 40 mW at their distal output, this critical value is exceeded. Only laserneedles of 35–40 mW distal light power induce the histamine release and, therefore, the acupuncture effects. When the distal light power is not sufficient, either none or weak, acupuncture effects are not generated.

The second important laser acupuncture parameter is the wavelength of the laser light. The laser wavelength determines the absorption of the photons in the tissue and therefore, the "penetration depth" of the light. For needle acupuncture treatments, the insertion depth varies because traditional Chinese acupuncture assumes that acupuncture points are located in different depths in the tissue. Photon penetration into tissue is inversely proportional to its absorption. To achieve a substantial penetration depth, we have to use laser wavelength which exhibits the lowest absorption in human skin, muscle, and fat tissue. It is believed that infrared light penetrates deeper in human tissue than red light, but is controversial. It has been recently demonstrated in experimental measurements[14] that the dispersion of the absorption coefficients in complex human tissue shows 2 distinct absorption minima: the lowest absorption exists at about 700 nm, i.e., red light of 700 nm exhibits the deepest penetration in human tissue. Therefore, the best choice for the wavelength of laser acupuncture devices is red light near 700 nm. There exists a second absorption minimum at 820 nm (infrared radiation) which is the second best choice. A bichromatic combination or mixture of red and infrared radiation would probably be the optimum for an efficient stimulation of acupuncture points. In conclusion, the most important laserneedle parameters that directly influence the therapeutic efficacy are laser irradiance (laser power per

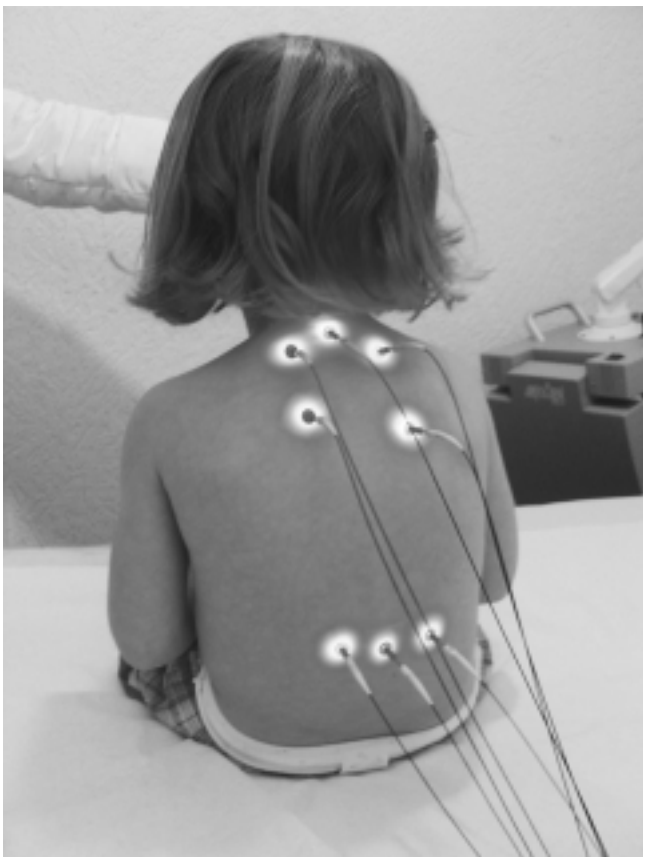

FIG. 3. Laserneedle treatment of a 6-year-old asthma patient (courtesy of R. Klowersa, MD, Berlin, Germany).

FIG. 4. Laserneedle treatment of cervical syndrome. Acupuncture point combination: SI 3 (Hou Xi), BL 62 (Shen Mai), BL 60 (Kun Lun), LI 4 (He Gu), LR 3 (Tai Chong). Treatment duration, 20 minutes; treatment frequency, 8 treatments, 3 times a week.

area) and absorption. In this context, the laser irradiance is physiologically equivalent to the stimulation strength of the laserneedle at the acupoint; the wavelength is equivalent to the "penetration depth" of a laserneedle.

At 40 mW distal laser power, which corresponds to an irradiation of 20 W/cm^2 and an emission wavelength of about 685–690 nm, we found that the stimulation effects at the acupoints are comparable to the stimulation effects of metal needles (Figure 2), although the patients did not feel any pain from the activated laserneedles. Further proof for that observation could be the fact that De Qi sensations are sometimes felt and reported by the patients during laserneedle acupuncture analgesia treatments.

In comparison to the large stimulation strength (large irradiance) which is necessary to induce the specific acupuncture mechanism, the energy that is transferred into the body during a laserneedle acupuncture treatment is rather moderate. Assuming a treatment duration of 1000 s (~17 min) using 10 laserneedles of 40 mJ distal energy, the total energy that is transferred into the tissue during the treatment is about 4 J. For better understanding and simplification and expressed in more familiar quantities, 4 J correspond to an energy transfer into the body of about 17 cal during a normal laserneedle treatment. This is much less than a teaspoon of yogurt. Due to the moderate dosage and its painless stimulation character, the laserneedle acupuncture is particularly suited for acupuncture treatments of children (Figure 3).

Is It Dangerous to Stimulate Acupuncture Points by Laser Light?

We have studied this important question carefully in the past. To determine the temperature effects of activated laserneedles, we have performed animal experiments as well as experiments with healthy volunteers. In this context, we used different biomedical methods: laser Doppler flowmetry and laser Doppler imaging, for registration of changes in microcirculation and different temperature measurement equipments.[15] The main result of these studies was that the temperature increased about 1 °C in the tissue by laserneedle activation. This increase is negligible and of no critical relevance. The temperature-increase of about 1°C is accompanied by an increase of the peripheral microcirculation in the acupoint area during laserneedle stimulation.[14]

To investigate micromorphological changes in the skin during and after laserneedle stimulation, we performed animal experimental studies.[16] We studied in particular the possible influence of laserneedle radiation on a necrosis of the epidermis, alterations of endothelia cells, blood vessels, and occurrence of microthrombosis using histological preparations of the skin. In all these investigations, we could not detect any micromorphological alterations of the animal (sus scrofa domesticus) skin.

From the results of these experimental studies, we can, therefore, conclude that laserneedle stimulation using these specific technical parameters does not induce measurable micromorphological changes in the illuminated skin.[15,16]

Is Laserneedle Acupuncture Therapeutically Equivalent to Traditional Metal Needle Acupuncture?

This question must be discussed under 2 different aspects. The first aspect regards the physiological equivalency that can be determined exactly by modern spectroscopic methods. The second aspect regards the clinical equivalency, which can only be assessed by a statistically significant number of therapeutic reports and clinical studies. Regarding the physiological

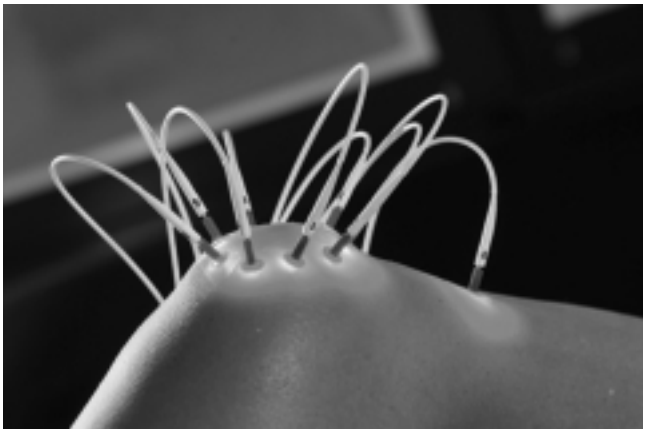

FIG. 5. Laserneedle regeneration therapy of a retropatellar chondropathy. Treatment time, 30 minutes; treatment frequency, 3 times a week; duration, 8 weeks.

equivalency, a larger number of scientific studies exist for the peripheral physiological effects as well as for the central physiological effects in the brain (summarized in reference 15). An important result was obtained by studying the alterations of the blood flow velocity in the ophthalmic artery during acupuncture of a visual acupuncture scheme. Combining 3 different acupuncture microsystems: the Traditional Chinese Medicine body acupuncture (acupoints Zanzhu/ BL 2 and Yuyao/Ex. 3), ear acupuncture (points eye and Liver), and Korean Hand Acupuncture (point E 2). Eighty-eight healthy volunteers were investigated in the study using metal needles and laserneedles. This scheme is known as particularly successful for the treatment of eye diseases. For the stimulation with metal needles, a significant increase (factor: 1.9) of the cerebral blood flow velocity in the ophthalmic artery was detected. The increase was observed only in the ophthalmic artery. In comparison, stimulation of the same acupuncture points using laserneedles resulted in an increase (factor: 1.6) of the blood flow velocity in the ophthalmic artery. Also, the oxygen metabolism in the brain, measured by near-infrared spectroscopic parameters,[17] was increased during the stimulation by a factor of 1.6 for metal needles and a factor of 1.8 for laserneedle stimulation. These results demonstrate that laserneedle stimulation may be nearly equivalent to the traditional metal needle stimulation.

The clinical equivalency between traditional metal needle acupuncture and laserneedle acupuncture can be assessed on the basis of 1.4 million laserneedle treatments worldwide. *No side effects* of laserneedle treatments have been reported.

The clinical reports and studies confirmed that laserneedle acupuncture is comparable to traditional needle acupuncture also from the clinical point of view. Laserneedle acupuncture has been employed to treat allergic diseases like rhinitis allergica, asthma bronchiale, neurodermatitis; neurological diseases like migraine, trigeminusneuralgia, herpes zoster neuralgia, hemiparese, phantom pain, paresis after stroke; orthopedic diseases like cervical syndromes (Figure 4), gonarthritis, rhizarthritis, epicondylitis, tendonitis, fibromyalgia, polyarthritis, spine syndromes; and pediatric diseases like bronchitis, asthma bronchiale, otitis media, bladder inflammations, enuresis, etc. Practitioners report better clinical efficacy of laserneedle treatments compared to metal needle treatments. Laser therapy results in enhanced microcirculation, increased ATP synthesis in the mitochondria, increased oxygen saturation levels in the blood, improved edema resorption, and improved anti-inflammatory effects. This is, perhaps, a remarkable difference to metal needles.

New Therapeutic Possibilities of Laserneedle Stimulation

Recent cell research studies with laserneedles demonstrate other therapeutic possibilities.[18] It was found that in-vitro studies of human osteoblast cells metabolism could be increased by a factor of 9.1 by laserneedle irradiation. A shift of the osteoblast-osteoclast-activity equilibrium to the bone regeneration side can be induced and maintained by the laserneedle therapy. Successful clinical treatments of osteoarthritic illnesses (Figure 5) like chondropathy and osteonecrotic illnesses, like morbus Ahlbäck, morbus Osgood-Schlatter, and morbus Perthes have been reported. In all these reports, the regeneration effects were achieved without any accompanying medication.

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