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.

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
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 dur-
ing 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 ef-
ficient 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 stim-
ulation.

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.” We are aware that
the term laserneedle is somewhat misleading; it suggests that
these instruments hurt the skin. This is not true; laserneed-
les 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-inva-
sive character and are free of the unpleasant metal needle
pain sensations.

HOW DOES LASERNEEDLE
ACUPUNCTURE WORK?

The mechanism of acupuncture analgesia has been stud-
ied extensively in the past 2 decades in Western countries. Studies using biomedical instruments have demonstrated the key role of the brain in acupuncture. It was also found that the insertion of a metal needle into an acupuncture point leads to a release of different chemical substances like hist-
amine, 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. Spe-
cific cortical areas like the pain-related cores of the hypothal-
umus and areas of the limbic system become activated.

The following effect transduction from the central nervous
system to the periphery, accompanied by a release of β-endorphins and other opioi gen or non-opiogen neurotransmitters,
uses efferent signal paths. This rather short description of the
basic mechanism of acupuncture analgesia shall illustrate the
essential point. That means that 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 ir-
radiation for the induction of discharges in peripheral noci-
ceptors? 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. Single
mast cells were isolated by a patch-clamp technique and il-
luminated 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. Conversely, a mast cell
that is not illuminated does not show any effects under the
same experimental conditions. This suggests that the irrad-
iation 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 ini-
tiate. This may be the basic mechanism of laser acupunc-
ture 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 hist-
amine concentration in the surrounding connective tissue.

We have found that the release of histamine from the con-
nective 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).](image-url)
of laser irradiation (light power per area) is exceeded. The laser needles had an irradiance of 20 W/cm², 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 laser needle 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/cm². For laser needles, which emit 40 mW at their distal output, this critical value is exceeded. Only laser needles 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 measurements14 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 laser needle parameters that directly influence the therapeutic efficacy are laser irradiance (laser power per area) and the wavelength of the laser light.
area) and absorption. In this context, the laser irradiance is physiologically equivalent to the stimulation strength of the laser needle at the acupoint; the wavelength is equivalent to the “penetration depth” of a laser needle.

At 40 mW distal laser power, which corresponds to an irradiation of 20 W/cm² 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 laser needles. Further proof for that observation could be the fact that De Qi sensations are sometimes felt and reported by the patients during laser needle 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 laser needle acupuncture treatment is rather moderate. Assuming a treatment duration of 1000 s (~17 min) using 10 laser needles 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 laser needle treatment. This is much less than a teaspoon of yogurt. Due to the moderate dosage and its painless stimulation character, the laser needle 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 laser needles, 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. The main result of these studies was that the temperature increased about 1°C in the tissue by laser needle 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 laser needle stimulation.

To investigate micromorphological changes in the skin during and after laser needle stimulation, we performed animal experimental studies. We studied in particular the possible influence of laser needle 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 laser needle stimulation using these specific technical parameters does not induce measurable micromorphological changes in the illuminated skin.

Is Laser Needle 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 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, 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, hemiparesis, phantom pain, paresis after stroke; orthopedic diseases like cervical syndromes (Figure 4), gonarthritis, rhizarthritis, epicondylitis, tendinitis, fibromyalgia, polyarthritids, 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. We explain that by the “double effect” of laser needles: they stimulate specifically the acupuncture points as metal needles do, and, in addition, they stimulate the surrounding tissue by laser light, resulting in typical laser therapy effects like enhanced microcirculation, increased ATP-synthesis in the mitochondria, and improved anti-inflammatory effects. Laserneedles, combine, always and during each treatment, the laser acupuncture with the laser therapy. 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. 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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