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The low level laser in palliative care

Abstract

It has been some forty years since the first publications emerged on the biological effects of low-powered lasers. Therapies with this kind of light have far outgrown their infancy and are now showing themselves to be a treatment that has come of age. The question is no longer whether low level laser treatment is effective but, far more interestingly, debates are being held about its most effective use. In the United States of America, Australia, the United Kingdom and Scandinavia, low level laser therapy (LLLT) is a well-accepted and widely-used form of treatment for a wide range of medical conditions. In the Netherlands, LLLT is mainly known for its success in helping people to stop smoking. LLLT has so much more to offer.

Key words: low level laser, biological effects, pain

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Introduction

The word "laser" is an acronym for "light amplification by stimulated emission of radiation". Normal light has a broad spectrum with many frequencies and intensities. Laser light consists of only one frequency (wavelength) and intensity. Laser light is, therefore, coherent, monochromatic and focused; by using a technique that stimulates emission, light can be amplified (intensified) [1]. To put it another way, we can produce light with an enormous amount of power.

The scientific use of light waves

The history of light therapy goes back a long way to the dark ages but it was only in the 20th century that the scientific use of certain light waves was used to improve physical conditions. It was **Albert Einstein** who predicted the existence of the laser in 1917 on theoretical grounds but the first effective laser was not made until many decades later. In 1960 **Theodore Maiman**, a physicist, wrote his first publication on laser radiation in relationship to health. In 1967, a Hungarian Professor of Medicine and surgeon named **Endre Mester** discovered that accelerated wound healing occurred with low intensity laser irradiation of wounds. Dr Mester is considered to be the father of laser therapy. He published multiple papers throughout the 1960s, 1970s and 1980s on the scientific investigation and therapeutic application of the ruby and helium neon lasers. Over the past 15 years the laser technique has played an important role in many kinds of medical discipline. The use of the laser in medicine is divided into that of high-powered and low-powered lasers, the latter also known as low level laser therapy (LLLT), the difference lying in the energy emitted. The action of LLLT is on firm ground, supported by over 2,500 scientific studies performed in many universities.

The high-powered laser (HPL)

High-powered lasers aim to destroy tissue and are used in dermatology, gastro-enterology, eye sur-

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gery, surgical and other disciplines. High-powered lasers are medically invasive and should only be used by doctors, as they can not only harm healthy tissue, but may also cause additional damage to ailing tissues.

The low level laser (LLL)

Low-powered lasers (low level lasers) have the same characteristics as HP lasers but their power output is greatly reduced. Low level laser denotes a low rise in temperature (less than1°C). LLLT is a safe type of light therapy that only influences pathological conditions or zones and normal tissue is not subject to any change as a result. LLLT is, therefore, an accepted form of therapeutic support for many kinds of treatments, hence its use in physiotherapy, podiatry, dentistry, dermatology, general practice, acupuncture, addiction medicine, sports medicine and veterinary procedures. Beauticians have also used LLL successfully in the treatment of, for example, acne, couperosis and rosacea.

How does LLL work?

Low level laser light is basically a ray of photons (small packets of energy) that is absorbed by the tissues and transformed in the mitochondria of the tissue cells into cell energy.

The LLL has the following physiological effects:
— increased growth factor response;
— increased ATP synthesis;
— increased cell proliferation;
— increased cell motility;
— increased angiogenesis;
— matrix remodelling is enhanced;
— modulation of the metabolism of neurochemicals i.e. serotonin and endorphins;
— reduced nociceptor activity;
— increased immune system response.

These physiological effects act on various cell types, such as macrophages, fibroblasts, endothelial cells and mast cells. This leads to increased and accelerated wound healing, pain reduction and increased immune response.

The setting determines the efficacy

In order to achieve the optimum effect for every condition, it is important to use the appropriate wavelength and the correct energy dose, which change with every type of treatment. Too high a dose will not produce the desired effect; too low will effect no change at all. The admission of pulsed light at a specific frequency also appears to be important. All these factors not only determine whether the laser energy reaches the tissues but also their response. This is one of the main reasons why, in the past and even now, many scientific studies have failed to demonstrate the positive effects of the LLL, leading to conclusions such as the LLLT not being scientifically proven to work. Inaccurate measurements and the incorrect reporting of dosages have been major shortcomings of phototherapy (LLLT) studies. As many as 30% of the reports published in this field either lack the relevant information needed to determine a dosage or report dosages that are altogether inaccurate. The high prevalence of dosage-related errors in published reports suggests that dosage determination errors are common among clinicians and other end users.

An example of the use and effect of laser probes

The example of probes and their use in LLLT is shown on Table 1.

In most cases, one single probe and a cluster were used in the same area.

Pulsed light or continuous light? That is the question

If the laser therapy is intended for wound healing, multi-pulsed light at low frequencies (2.5–20 Hz) provides the best results; if it is for pain control, multi-pulsed light at medium frequencies (73–700 Hz) are used; and to ease chronic inflammations and painful joints, multi-pulsed high frequencies (5–20 KHz) should be used. This turnes chronic inflammation and pain into an acute type. Than in second instance, by using low frequency pulsing (2,5–20Hz) the inflammation or pain subsides.

Side-effects and contraindications

Since LLLT is a non-invasive, non-destructive technique, there are almost no side-effects. The following contraindications are usually mentioned.

Direct irradiation of the eyes

Class 3b lasers are potentially harmful to the retina — though retinal damage is highly unlikely. Safety goggles must, however, be worn by both patient and practitioner.

Table 1. Example of probes and their use in LLLT

Probe	Penetrating effect	Cellular response	Used for
675 nm 30 mW	Of its power, only 5% penetrates the skin and below	Good growth factor response	Ulcers and wounds Post-operative procedures
		Bacterial static effect	Skin conditions Infection control
		Virus static effect	Herpes labialis
	20% penetrates subcutaneously	Excellent growth factor response	Tissue repair underneath the dermis Soft tissue/sports injury
820 nm	More effective penetration and energy delivery	Endorphin delivery	Acupuncture point stimulation
200 mW	Proven energy delivery up to 3 to 4 cm deep in the tissues	Higher serotonin levels	Trigger point therapy Pain relief Warts Smoking cessation
Cluster	Series of wave-lengths combined for excellent	Excellent growth factor response over larger areas penetration and radiation volume	Ulcers and wounds Post-operative procedures Skin conditions Infection control

Pregnancy

Laser is contra-indicated for use over the pregnant uterus. It may be used on the pregnant woman as an adjunct to the other modalities being used for the treatment of back pain or other complaints.

Carcinoma

Although research has shown an increase in apoptosis in neoplastic cells and no effect on non-neoplastic cells after infrared pulsed laser treatment [11], generally the experts advise not to use laser over any known primary or secondary lesions. Laser treatment may be given for pain and other symptoms relief during the terminal stages of the illness with the full consent of both patient and consultant involved.

Thyroid

Laser should not be used over the thyroid gland.

Haemorrhage

It is conceivable that laser-mediated vasodilation may worsen the haemorrhage.

Immune suppressant drugs

Laser therapy is contra-indicated for patients on these drugs

Treatment over sympathetic ganglia, the vagus nerves and cardiac region in patients with heart disease

Laser therapy may significantly alter neural function, and is therefore contra-indicated over these regions in patients with heart disease.

LLLT and pain control

The LLL has been used for many years with positive results both in rheumatology and physiotherapy, and a number of studies have confirmed its beneficial effects [2–5].

LLLT and palliative care

In palliative care the main goal is to provide optimum relief of suffering in all dimensions, whether physical, psychological, psychosocial or spiritual.

In this setting, the main areas for physical problems are pain, nausea and vomiting, dyspnoea, constipation and diarrhoea but many other conditions arise in the terminal phase. Due to the bedridden state of many of the patients, decubitus or pressure sores are a constant worry but other pre-existing conditions, such as joint pain due to arthritis, might also need attention. Chronic venous ulcers present a considerable reduction in a patient's quality of life and, once attended to, can greatly improve someone's sense of well-being, even in a palliative setting. In addition to the above, treatments in oncology often have unpleasant side effects (nausea, oral mucositis, xerostomia and severe pain due to radiotherapy to the head and neck).

Since LLLT is painless and easy to perform, it can be highly beneficial in palliative care. LLLT is currently used in our hospice as a complementary treatment, for pain relief, prevention and treatment of decubitus and wound healing. Since the laser apparatus that we use (Omega XP) has an acupuncture mode, it is also possible to stimulate certain acupuncture points to treat conditions such as nausea.

Trigger point stimulation can also lead to better pain control.

Our results with the use of the LLL in our hospice are at least promising and in some cases even extraordinarily positive, although we are, of course, referring here to individual cases and by no means to scientific research studies. In general, it is very hard to conduct randomized, controlled, double blind cross over studies in such a setting but hospice care is primarily concerned with making the maximum effort for the optimal relief of suffering. A literature search to discover whether the LLL is being used elsewhere in palliative care also showed some promising results, such as those mentioned below.

Beneficial effects of the LLL were described for the prevention and treatment for radiation-induced mucositis in head and neck cancer [6]. Some literature described the improvement of quality of life [7].

All patients tolerated the laser treatment without any adverse effect or reactions. The result showed a significant difference in pain and mucositis ($p < 0.001$) between the two groups. At the end of radiotherapy (after 6 weeks) mean pain score and mucositis grade were significantly lower ($p < 0.001$) in the study group compared to the control.

A positive effect was found on lymphoedema secondary to breast cancer [8].

This study has found that both conservative and LLL treatments are effective in treating lymphoedema, and that many patients consider LLLT as a viable treatment option.

Phototherapy improves healing of chronic venous ulcers [9].

Ulcers treated with phototherapy healed significantly faster than controls when compared at day 30 ($p < 0.01$), day 60 ($p < 0.05$) and day 90 ($p < 0.001$) and similarly healed faster than the placebo-treated ulcers. Medium- and large-sized ulcers healed significantly faster with treatment (> 40% rate of healing per month) than placebo or control ulcers ($p < 0.05$). Phototherapy promotes healing of chronic venous ulcers, particularly large recalcitrant ulcers that do not respond to conventional treatment.

Laser therapy converts diabetic wound healing to normal healing [10].

In this induced-diabetes model, wound and burn healing were improved by 40.3% and 45%, respectively, in 633-nm laser dosimetry experiments, and diabetic wound and burn healing was accelerated by phototherapy. LLLT is recommended, especially after major surgery, in those with impaired healing, such as diabetics and the elderly.

The *Photomedicine and LLLT Literature Watch* produces an impressive list of articles every two months of both basic scientific research and clinical studies with LLL. Increasingly, the effects of laser light are becoming apparent and, with more standardized treatment programmes, a positive future for the general clinical use of the LLL lies ahead of us. Palliative care is practised mainly at the end of life (the treatment of chronic illnesses could also be called palliative care but palliative care is usually associated with care for the terminally ill), but that does not mean that new techniques should not be considered. On the contrary, any intervention that is beneficial and does not produce side effects or cause harm or suffering must be used to provide optimum relief for patients.

Conclusions

Low level laser therapy is not new in clinical medicine, but its use in the past, with very contradictory results, has caused its use in some countries, such as the Netherlands, to become limited or even unknown.

A therapeutic device is often only as effective as the clinical skills of the end user, and some clinicians are similarly only as good as their tools allow them to be. On the one hand, the World Association for Laser Therapy (WALT) has proposed guidelines and standards for designing and conducting clinical studies; on the other, there is a great need among clinicians for effective treatment protocols. Close cooperation between clinicians and producers of laser devices will eventually lead to the more widely and successful use of the low level laser.

From personal experience, both in general practice and in hospice care, I am confident that LLLT will eventually be widely used by clinicians in general practice, nursing homes and hospices.

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