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Background on Low Laser Light and Theory of it's Proposed Benefits for Hair Loss

For the Laser to become a medical device for benefiting the person with hair loss from genetic causes, the devices that are being promoted must prove that they are safe for use and that they are effective to meet the claims of those who promote it. It is critical for the consumer to know that what he is buying (either a service or a device) does what he has bargained for and does not expose him/her to any undo risks. There have been a great deal of claims for benefit of these laser hair devices along with proposed mechanisms of action. The purpose of this document is to review the information that is available (substantiated and unsubstantiated) so that you, the reader, can judge whether or not Laser treatment for hair loss is appropriate for your situation.

The Low Laser Therapy (LLT) for hair loss is claimed to work by supplying energy to the body in the form of non-thermal photons of light. The technology is further claimed that in the right application, the body is able to absorb this external energy on a cellular level and transform light energy into chemical energy, which the body then uses to accelerate the normal healing rate of tissue for a wide range of ailments. .

For the body to be able to absorb and transform the energy, certain parameters need to be defined such as treatment time, wavelength of the light energy, dosage, etc.. with the various techniques.

For a Laser, the wavelength of light is extremely important, since the wavelength ultimately decides the penetration depth in the target tissue. Red light from a 670 nm continues-wave is claimed to be less well absorbed in blood, which is also red, so the penetration rate is much greater than from other hair lasers closer to the red spectrum (632,8 nm, 635 nm 650 nm etc.) Since wavelengths from 670 to 690 nm support the redox processes (oxidization processes) it is believed that the 670nm wavelengths show better efficacy in therapeutics than lower wave length lasers such as the He-Ne-lasers (632,8 rim) etc. Low-energy visible light (LEVL) has been shown, in some studies, to stimulate certain cell functions. This is called "photobiostimulation" and has been used over the last three decades for treating a range of conditions, including soft tissue injuries, severe wounds, chronic pain, and more. Although the mechanism of photobiostimulative processes is still being debated, in order to interact with the living cell, light has to be absorbed by intracellular chromophores. In a search for the chromophores responsible for photobiostimulation, endogenous porphyrins, mitochondrial and membranal cytochromes, and flavoproteins were found to be favorable candidates. The above-mentioned chromophores are photosensitizers that generate reactive oxygen species (ROS) following irradiation. As the cellular redox state has a key role in maintaining the viability of the cell, changes in reactive oxygenation may play a significant role in cell activation. There is suggestive evidence demonstrating various ROS and antioxidants are produced following LEVL illumination. There are suggestions that the change in the cellular redox state plays an important role in maintaining cellular activities and leads to photobiostimulative processes

In the field of photochemistry, the light must be absorbed before photochemistry can occur. This is a very simple but powerful concept for this field and as such, is basic to the 'laws' of the science. Of the lasers in the visible region 670nm laser is considered to provide superior absorption (penetration). In 1993 a study on rat schwann cells demonstrated the variations between 670, 780 and 830 nanometer absorption. The highest absorptions were exhibited at 670 nm and the lowest at 830 nm. However there is clinical evidence that in contrast to other wavelengths, the 830 nm laser light produces specific beneficial biological reactions that are not produced by other wavelengths. Because the scalp skin is thin, the deep penetration of the 830 nm wave length may be too deep to get the full benefits to the rather superficial hair follicles and is therefore not needed for hair therapeutics. Today, the wavelengths most commonly used for therapeutic purposes are 632,8 run, 635 nm, 650 nm, 660 nm, 670 nm, 780 nm, 820 nm, 830 nm, 904 nm (GaAs lasers). Except for GaAs, all these lasers usually produce a continuous beam but some may also be pulsed. The infrared lasers, invisible to the eye, are more suitable for muscle therapy (deep penetration) and are not used in hair loss therapy because the penetration depth is not needed. With these lasers, eye protection is needed and these devices are considered Class IIIb devices by the FDA. (Visible light ranges from: 400 nm (violet) - 700 nm (red) Infrared light: Above the 700nm Infrared light, the light is invisible.

For hair applications, the first and most significant condition in choosing laser wavelength is depth penetration, which should be sufficient to target hair bulbs typically resting at a 5-6 mm depth.

Visible red light, at a wavelength of 660 nanometers (run -1 nanometer is equal to one billionth of a meter), penetrates tissue to a depth of about 8-10 mm so the entire hair organ will be covered to a depth just beyond the hair bulb. Visible red light also can theoritically be effective in the entire scalp and might include; wounds, cuts, scars, folliculitis, etc... Higher Infrared light in the non-visible area will penetrate to a depth of about 30-40 mm and therefore might make it effective in the treatment of joints, deep muscle, etc… (areas of application which are used today).

Lasers can operate in two modes: (1) either continuous-wave (cw) or (2) pulsed operation modes. The biological responses of the same cells to pulsed and continuous-wave (CW) light of the same wavelength, average intensity, and dose can vary.

Supporters for pulsed LLLT produce the following arguments for why pulsed might be better:

- It is believed that pulsed LLLT can stimulate tissue repair and regeneration
- It is believed that pulses stimulate cell, activity. Theory suggests that rapid pulsing of LLT starts to simulate a continuous beam.
- It is believed that pulsed LLLT can regulate biological rhythms or cycles
- It is believed that pulsed light produces deeper penetration compared to continuous wave. More science is needed to define and prove such claims.
- It is believed that pulsed LLLT has an anti-imflamatory effect.
- It is believed that when both pulsed light is used in combination with the visible infrared red light spectrum, it might have value for various hair treatments which are becoming the focus of marketing and research activities today.

There are two ways to create the pulsations:

1. By turning the lasers on / off mechanically
2. By transfer the light in specific patterns through internally moving parts to the administration device. The laser diodes can be fixed within a hood and by moving band shaped fields of light repeatedly over the area a pulsating stimulation of the hair follicles of the skin can be simulated. One of the commercial systems available today, Laser Hair Care, uses this proprietary approach and this company believes that this increases the stimulatory effect of LLLT on the scalp and hair.

The goal of LLLT is to increase the circulation of blood to the follicle area and to stimulate the hair organ (nerves, muscles and growth centers of the hair follicle). The effects of such LLLT to stimulated, enhance or speed up the normal life and production cycle of the exposed hair follicles is presently being studied and will fast become the science by which this technology will judged.

When dosing LLLT (often referred to as "fluence"), the energy is measured in J (joules), the area in cm2, and, consequently, the dose in J/cm2. To induce an optimal effect, the exposure dose has a lower and upper limit. The optimum theoretical dose probably lies somewhere in the middle. It is believed that repeated doses, given at intervals, induce stronger effects than the same total dose given in one treatment and as such, the treatment effect is cumulative. This would mean that repeated doses with a suitable, relatively short interval might give an added response. Fluences between 0.24 - 1.0 J/cm2 on one hand and 3 - 4 J/cm2 on the other hand, may be more favorable for different conditions.

I have obtained access to the Laser Hair Care device which produces 108 Joule in 15 minutes spread over a density between 0.12 - 1.09 J/cm2/15 minutes (10.8 J/cm2/15 minutes). In a scalp blood microcirculation study done with the Laser Hair Care device in 1996, Pontinen demonstrated that the Laser Hair Care (60 mW) fluencies increased blood flow while He-Ne laser 0.01 J/cm2 had no effect. The same study demonstrated that light emitting diodes (LED) with fluences between 0.68 - 1.36 J/cm2 (112.5 mW) produced Vasoconstriction* (reduced blood flow). Some believe that an increase in blood supply will parallel an increase in the demand for blood supply and as hair is amongst the highest metabolic organs in the body, the presumption that the demand for blood and oxygen from the hair organ is driving the higher blood supply reported in this and other similar studies. Speculation for interested third parties need science to back this assumption up with better studies that show the relationship between the size and mass of the sum of the hair organs when compared with pre-treatment metrics.

The power, watt or milliwatt, of a laser determines how much energy is initially delivered to the tissue surface and along with the wavelength, the power at any given depth of penetration. Energy density (Joules / entimeter2) is equal to the power of the laser in watts multiplied by the treatment time in seconds, divided by the surface area irradiated in square centimeters. Laser light has the unique properties of monochromaticity, (a single wavelength), coherence (travels in a straight line), and defined location (concentrated beam). Amongst the questions needed to be better understood is the effects of LLLT on the cells, namely: Do cells exposed to LLLT convert the energy into chemical energy and can they use that energy for repair, regeneration, or growth stimulation? I will be writing more and offering reviews of a variety of scientific papers on the use of LLLT in the near future.