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Low Level Laser Therapy and LED Therapy in the Management of Venous Leg Ulcers

Abstract

Low-Level Laser therapy (LLLT) and Light Emitted Diode (LED) therapy can shorten the time period needed to achieve complete healing of venous leg ulcers. A review of the literature revealed that differing the wavelengths of light-emitting diode devices have many beneficial effects, including wound healing and venous leg ulcer healing. Research on LED and LLLT mechanisms has yielded multiple pathways by which clinical benefit has been achieved. LED therapy appears to affect cellular metabolism by triggering intracellular photobiochemical reactions. Observed effects include increased ATP, modulation of reactive oxygen species, the induction of transcription factors, alteration of collagen synthesis, stimulation of angiogenesis, and increased blood flow. The authors' clinical experience with a specific light-emitting diode and LLLT device (RGn-MILTA™) was mixed, depending on the condition being treated, and was likely influenced by the device parameters.

Keywords: low-level laser therapy, light emitting diode, photomodulation, wound healing, venous leg ulcers

Treatments in the management of venous leg ulcers

A venous leg ulcer is a chronic skin wound which does not heal spontaneously. In more than 90% of cases, this wound is due to a complication of vascular disease such as artherothrombosis or venous insufficiency.[1] This disease damages and can induce eventual destruction of the capillaries that deliver oxygen and nutrients to the skin and subcutaneous tissues (ischemia). Other causes could be an accumulation of waste products due to a bad lymphatic system and venous system (edema) or microcirculation dysfunction.[2]

To cure this kind of chronic skin wound, a physician should first identify if the venous leg ulcer is a developing ulcer *(Figure 1)* or a treatable ulcer. In the first case the ulcer presents a white border (budding skin), inflammation and a purulent background. This is a toneless ulcer. In the second case, the ulcer has net borders, no budding skin and a clean background. This is an ulcer that can be healed.

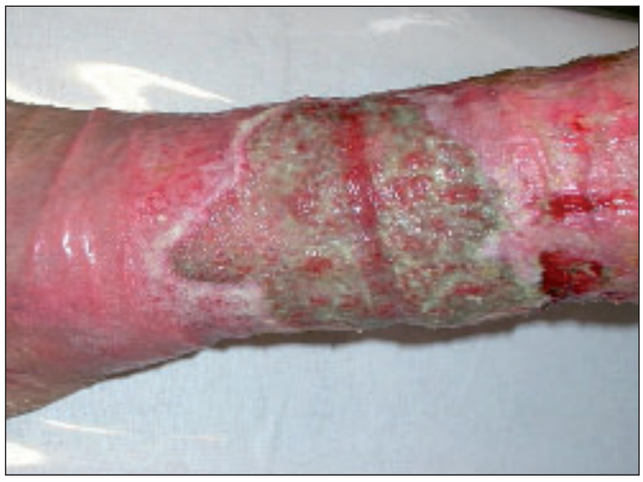

Figure 1. Developing venous leg ulcer.

For developing ulcers, there is no specific treatment. Progression could have slown down, inflammation reduced, the wound could be cleaned. However, as the budding of the skin does not stop, the wound will keep on extending. Then, once stopped, there are five steps to follow in order to heal a venous leg ulcer:

- Relaunch venous reflux
- Clean the wound and keep the tissue healthy
- Reduce peripheral inflammation
- Restore microcirculation
- Enhance wound healing (collagen synthesis)

In order to manage venous leg ulcers, there are more than 10 types of treatment acting on at least one of the aforementioned healing steps. Most of these methods such as compression, drugs (Phlebotropics, Antibiotics, Heparins, Pentoxifylline, Stanozolol, Zinc, Antiplatelet agents), and surgery, focus on relaunching venous reflux. In surgery, there have been many proceedures at the heart of medical studies such as endovenous laser treatment and radiofrequency, or deep venous surgery (valvuloplasty). However, results showed that in the last 20 years, the clinical results present a healing rate of lower than 50%[3,4] in 12 weeks. This underlines the importance of cleaning the wound with a dressing or larvotherapy but also reducing peripheral inflammation, restoring microcirculation and enhancing wound healing with photomodulation.

Photomodulation in the management of venous legs ulcer

Photomodulation will allow for facilitation the healing process of a venous leg ulcer by acting on the three last steps mentioned above. It combines Low-Level Laser Therapy →

(LLLT) *(Figure 2)* and Light Emitting Diode (LED) therapy *(Figure 3),* in other words, this concept is based on the use of focused cold lasers (LLLT) which can penetrate the skin by 10cm or non-focused cold lasers (LED) which have an action on surface of the skin (1-2 cm).

In both cases, the light emitted by the LLLT and by the LED therapies stimulates photoreceptors found on human cells, which sends an in-depth message to trigger various biological responses. Photomodulation mainly influences the Cytochrome C oxidase, the 4th unity of the mitochondrial respiratory chain. It stimulates the production of energy in the form of Adenosine triphosphate (ATP), which is required for many biological activities.[5] For example, according to the several wavelengths of a LED, different biological activities are associated. Blue LEDs (~430 – 500 nm) are known for their antibacterial action[6] and red lights (~620 – 750 nm) for their anti-ageing impacts.[7]

According to several scientific studies, LLLT and LED therapies enhance:

- Collagen synthesis: In a study[8], irradiation of isolated diabetic human skin fibroblasts with 5 J/cm^2 at a wavelength of 660 nm showed a significant increase in cell migration, proliferation, and collagen content. Another study [9] showed that the 800-nm diode laser irradiation induces skin collagen synthesis by stimulating TGF-ß/Smad signaling pathways.
- Wound healing: Different clinical studies[10,11] underlined the effect of LLLT and LED in diabetic wound healing. In the first one, it shows that in a group with LLLT (685 nm, energy density 10 J/cm) there is a mean acceleration of wound healing regarding the control group with complete healing in 11 weeks while in the second control group, complete healing was noticed after 14 weeks.
- Microcirculation: In an observational study[12], researcher discovered that there is increased blood flow in an area exposed to 5 J/cm^2 at a wavelength of 780-nm. This augmentation was determined by the use of contrast-enhanced magnetic resonance imaging (MRI). The signal to noise ratio increases by more than 0.35 ± 0.15 (range 0.23-0.63) after irradiation.
- Reduction of inflammation: LLLT therapy is known for its impact on inflammation. Several clinical, and in vitro studies showed this effect.[13]
- Cells division: Various studies[14] show the impact of LLLT and LED therapies on cell proliferation. Their actions influence the production and stimulation of growth factors.

All of these functions are key factors in the management of venous leg ulcers.

LED and LLLT device (RGn-MILTA™) in the management of venous leg ulcers: observational trial

The RGn-MILTA™ device mixes three different biotechnologies; Low-Level Lasers (830 nm), infrared Light Emitting Diodes (850-890 nm) and polychromatic Light Emitting Diodes (variable according to the program) with various programs to treat venous leg ulcers and globally, healing wounds. It owns two Photon polychromatic Emitters and one Polychromatic Emission Panel which present LLLT, and LED. This device was the subject of an observational trial whose aim was to show its healing property on wounds and venous leg ulcers.

The trial was led by the Société Française d'Accréditation Santé (S.F.A.S.). The RGn-MILTA™ protocol consists of three sessions of RGn-MILTA™ per week over a period of four weeks. In each session, several programs were used to optimize the healing process.

- Photon polychromatic Emitter 1 is placed on the heart for a "cardio-vascular" program (5 minutes): To stimulate microcirculation
- Photon polychromatic Emitter 2 is placed on the liver for an "hepato-detox" program (5 minutes): To clean the liver
- At the same time, as close together as possible, the polychromatic emission panel is placed for an « ulcer » program (20 minutes): To accelerate the healing process
- Then photon polychromatic Emitter 1 is placed on the femoral artery for a "hemo-detox" program (12 minutes): To stimulate microcirculation
- Photon polychromatic Emitter 2 is placed on the popliteal

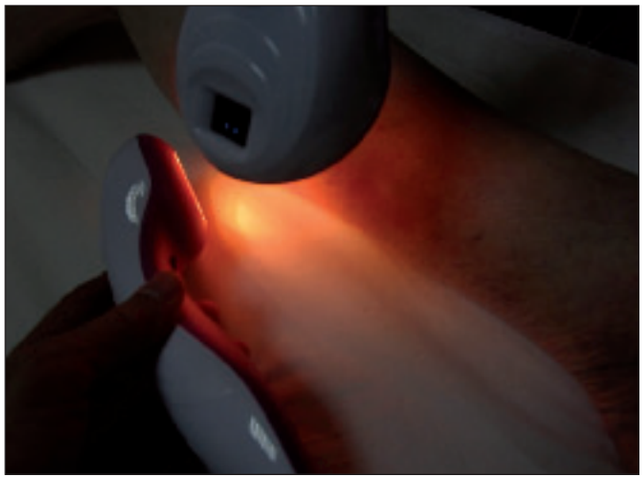

Figure 2. Low-Level Laser Therapy device.

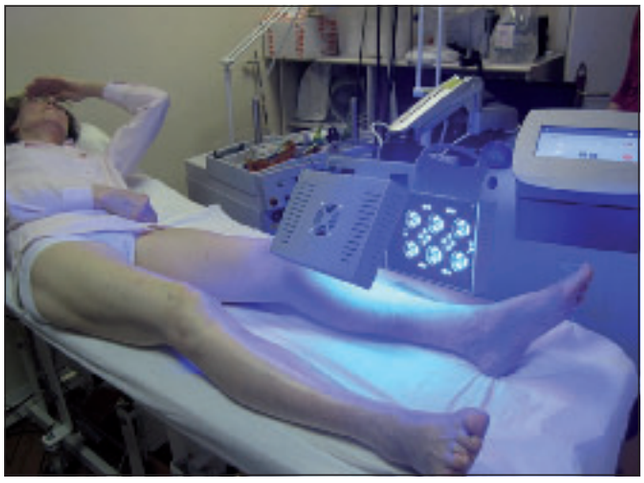

Figure 3. Light Emitting Diode device.

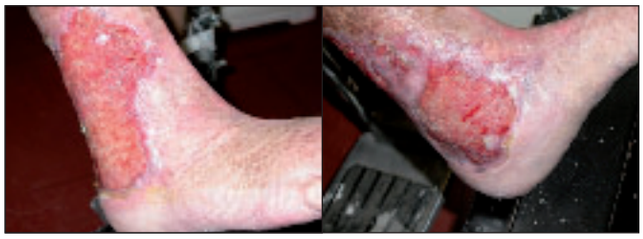

Figure 4. RGn-MILTA™ protocol, standardized digital photographs before and after 12 weeks.

for a "hemo-detox" program (12 minutes): To stimulate microcirculation
- Finish with a healing Photon polychromatic Emitter for an "ulcer" program (5 minutes) very slow treatment of the area as close together as possible: To accelerate the healing process

Patients were aged 50 years or over with a venous leg ulcer dating from 1 to 24 months, whose size was between 2 and 50 cm^2, localized in the peri-malleolar region of the lower tier of the calf. They were able to walk unassisted.

Three evaluation visits were carried out; before the start of the sessions, after two weeks (6 sessions) and at the end of the therapy (12 sessions). For each visit, several parameters of efficacy were measured such as a high-frequency Doppler ultrasound of the vessels of the lower limbs, planimetric measurement of the wound *(Figure 5),* a visual analog scale for the budding skin and pain encountered, and the taking of standardized digital photographs.

Results were very encouraging as after 4 weeks an important decrease of the venous leg ulcer sizes were observed *(Figure 4).* Regarding the pain, the visual analog scale showed a significant reduction of the pain associated with the ulcer as well as with the budding skin.

Regarding these results, an in-depth study will be lead in order to Assess the acceleration property of RGn-MILTA™ device in the field of wound healing in decubitus with control groups (placebo) and treatment groups (Milt'therapy).

LLLT and LED therapies and their multifactorial actions (anti-inflammation, anti-bacterial, improvement of microcirculation, stimulation of collagen synthesis) seem to be a real asset in the management of venous leg ulcers. It completes the action of compression and dressing by accelerating the healing process. But it could not be used alone since it does not enhance blood reflux which is the first step in treating a venous leg ulcer.

To follow the five steps of venous legs ulcer treatment, a treatment protocol should be constructed which includes compression and/ or drugs for enhancing blood reflux, dressing and/or larvotherapy to clean and keep the wound healthy and photomodulation (LLLT and LED therapy) to reduce peripheral inflammation, restore microcirculation and enhance wound healing (collagen synthesis). ■

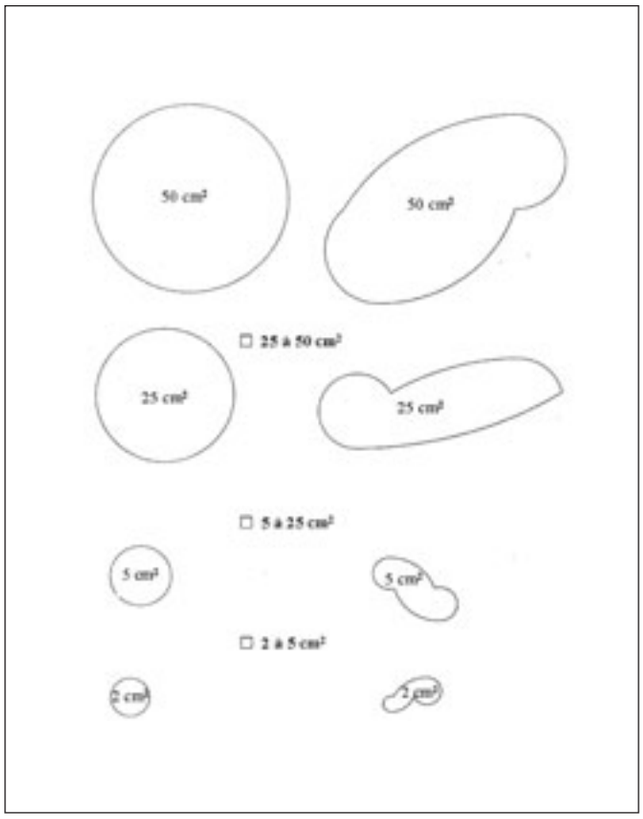

Figure 5. Planimetric measurements.

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