ISSN: 2476 - 2415

Research Article

International Journal of Clinical & Experimental Dermatology

LED Treatment for Chronic Leg Ulcers

Fatimazahrae BENHAYOUN*, F.HAL and S. CHIHEB

Dermatologie department, CHU Ibn Rochd, Casablanca

*Corresponding Author
Fatimazahrae Benhayoun, PhD, FRCP Dermatologie Department, CHU Ibn Rochd, Casablanca

Submitted: 2024, Jan 05; **Accepted:** 2024, Mar 15; **Published:** 2024, Apr 01

Citation: BENHAYOUN, F., HAL, F., CHIHEB, S. (2024). LED Treatment for Chronic Leg Ulcers. *Int J Clin Expl Dermatol, 9*(1), 01-05.

Abstract

Introduction

Chronic leg ulcers impact patients' quality of life and pose a therapeutic challenge for dermatologists. The aim of this study was to evaluate the efficacy of LED monotherapy on healing and pain in the treatment of chronic leg ulcers.

Materials and Methods

his prospective descriptive study was conducted at the Laser Unit of the Dermatology and Venereology Department at Ibn Rochd University Hospital in Casablanca from July 2021 to May 2023. Inclusion criteria were the presence of a leg ulcer and age > 18 years. Exclusion criteria included uncontrolled diabetes and pregnancy. We used a polychromatic LED device combining five colors: violet (415nm), blue (465nm), yellow (590nm), red (630nm), and infrared (850nm), in continuous mode with total fluences of 48J/cm2 and 64J/cm2.

Results

23 patients were recruited, with 78.3% being male and a male-to-female ratio of 3.6. The average age was 44.5 years (19-70 years). Vascular etiology was found in 65.2% of cases. Enzyme deficiency was observed in 17.4%: prolidase deficiency and protein C deficiency. Leg ulceration related to a systemic disease was noted in 17.4%. Hematological etiology was identified in 8.7%: sickle cell disease and thalassemia. At the end of treatment, pain regression was noted in 72% of cases. Healing was complete in 26.1% of cases and partial in 73.9%.

Conclusion

Chronic ulcers represent debilitating conditions with challenging healing. LED therapy using a combination of colors (violet, blue, yellow, red, infrared) accelerated the healing of chronic leg ulcers of various etiologies and reduced pain. Further large-scale comparative studies are needed to assess the effectiveness of LED therapy with color combinations in the healing of chronic leg ulcers and to establish practical usage recommendations.

1. Introduction

Leg ulcers represent a spectrum of chronic conditions with varied etiologies, posing a significant public health challenge. The prevalence of chronic leg ulcers in the general population is high, ranging from 0.5% to 1%, and they are a major cause of morbidity, leading to substantial healthcare costs and a diminished quality of life for the patient [1]. Leg ulcers are a frequent reason for consultation and often result in hospitalization in dermatology.

Etiological treatment is crucial, as well as addressing risk factors. Local and systemic treatments for chronic leg ulcers currently serve as adjunctive therapies. Healing chronic ulcers is an increasing challenge that requires innovative strategies. The use of LED light has been proposed in chronic wound healing for two decades, with variable results associated with emitted wavelengths, which appear to have specific actions on different phases of the healing process. Therefore, we conducted this study to assess the effectiveness of LED monotherapy in the treatment of chronic leg ulcers.

Leg ulcers represent a spectrum of chronic conditions with varied etiologies, posing a significant public health challenge, leading to substantial healthcare costs and a diminished quality of life for the patient. The objective of this study is to evaluate LED monotherapy in the treatment of leg ulcers.

2. Patient and Methods

This study was conducted from July 2021 to May 2023. Inclusion criteria were the presence of a leg ulcer and age > 18 years. Exclusion criteria included uncontrolled diabetes and pregnant women. The ulceration was directly exposed to LED light at a distance of 5 cm from the light surface. Two main protocols were studied (Table 1): varicose ulcer 'D34' (total fluence 48 J/cm2, total energy 28.8 kJ, polychromatic, wavelengths 415-850 nm, exposure time 10 minutes), and infected scar 'D37' (total fluence

64 J/cm2, total energy 38.4 kJ, polychromatic, wavelengths 415-850 nm, exposure time 12 minutes). The chosen protocol varied based on the clinical appearance of the ulceration. The interval between sessions was 48 hours, and the treatment duration was 12 weeks. Pain was assessed by VAS before the start and at the end of treatment. Healing was assessed as complete (100% closure of the ulcer), good (reduction in surface area between 60 and 99%), moderate (reduction in surface area between 30 and 59%), poor (reduction in surface area between 1 and 29%), and non-responsive. Data were entered and analyzed using Excel software.

All patients were given informed consent prior to inclusion. The study was conducted in accordance with the principles of the Declaration of Helsinki and local ethical guidelines (Ethics Committee for Biomedical Research, Faculty of Medicine and Pharmacy, Casablanca, Morocco). Patients gave their consent for photos to be taken and for their data to be used. Patient anonymity was respected.

varicose ulcer	infected scar
- total fluence 48 J/cm2 (blue 4 J/cm2, yellow 20 J/cm2, red 20 J/cm2, IR 4 J/cm2) - total energy 28.8 kJ, - polychromatic, wavelengths 415-850 nm (from blue to infrared) - exposure time 10 minutes	- total fluence 64 J/cm2 (blue 14 J/cm2, yellow 18 J/cm2, red 24 J/cm2, IR 8 J/cm2) - total energy 38.4 kJ, - polychromatic, wavelengths 415-850 nm, - exposure time 12 minutes

Table 1: Protocol Characteristics

3. Results

23 patients were recruited (table 2). 78.3% of the cases were males, with a sexe ratio of 3.6. The average age was 44.5 years (19–70 years). The main medical history included venous insufficiency (30.4%), smoking (21.7%), enzyme deficiency (17.4%), hypertension, diabetes, and systemic disease (13% each), dyslipidemia, and hemoglobinopathy (8.7% each). The average duration of the condition was 10.43 months (1–12 months).

Vascular etiology was found in 15 patients (65.2%): venous (43.5%), arterial (17.4%), and mixed (4.3%). Enzyme deficiency was found in 4 patients (17.4%): prolidase deficiency and protein C deficiency (2 patients each). A leg ulcer related to a systemic disease was found in 4 patients (17.4%). Hematological etiology was found in 2 patients (8.7%): sickle cell disease and thalassemia.

The LED protocol used was the varicose ulcer protocol in 52.2% and the infected scar protocol in 47.8%. The ulceration was photographed at the beginning of the treatment (day 0) and at weeks 4, 6, and 12 (Figures 1, 2).

Healing was clinically assessed by granulation tissue formation, epithelialization, and reduction in ulcer diameter. At week 12, complete healing (epithelialization) was observed in 6 patients. Healing was partial (granulation tissue formation, reduction in ulcer diameter) in 17 patients.

Pain assessment was done using the visual analog scale (VAS). Pain was present in 18 patients (78.3%) and absent in 5 patients (21.7%). Pain regression was noted in 72% of cases. Perilesional erythema was observed in 1 patient. No other adverse effects were observed.

Number of cases	23 cases
Demographic characteristics	
Mean age	44,5 years old
Sexe ratio	3,6
Medical history	
Venous insufficiency	30,4%
Smoking	21.7%
Enzyme deficiency	17,4%
Hypertension	13%
Diabetes	13%
Systemic disease	13%
Dyslipidemia	8,7%
Hemoglobinopathy	8,7%
Etiology	
Venous leg ulcer	43,5%

Arterial leg ulcer	17,4%
Mixed leg ulcer	4,3%
Prolidase deficiency	8,7%
Protein C deficiency	8,7%
Leg ulcer related to a systemic disease	17.4%
Hematological	8,7%

Table 2: demographic characteristics of patients

Figure 1: Venous ulcer in a 43-year-old patient with thalassemia at baseline (a); reduction in ulcer diameter at S6 (b), then at S12 after LED treatment with varicose ulcer protocol (c)

Figure 2: Arterial ulcer in a 70-year-old patient, measuring 8cm in diameter at baseline (a); granulation tissue at S2 after LED treatment with infected scar protocol (b); healing with reduction in ulcer diameter at S4 after LED therapy (c), and complete healing at S12 (d).

4. Discussion

The therapeutic benefits of LED light have been known since the 1990s. However, many of the reported results show discrepancies, primarily due to methodological bias or a lack of standardization in studies [2-4]. Through our case study, we aimed to demonstrate the effectiveness of LED monotherapy in the treatment of chronic leg ulcers, particularly in accelerating wound healing and reducing pain. All our patients treated with LED monotherapy showed partial healing after 4 to 12 weeks of high-intensity LED treatment, with a 72% reduction in pain. Complete healing was observed at 12 weeks in 6 patients (26.1%) with small-sized ulcers, unlike larger ulcers (> 5 cm), which did not completely heal after 12 weeks of LED monotherapy. This suggests that the ulcer diameter may influence the therapeutic response. Schindl et al, through a series of 20 cases treated with low-intensity laser (fluence 30 J/cm2), evaluated factors associated with wound closure duration in low-intensity light treatment [5]. They indicated that healing time is correlated with the ulcer's etiology and diameter (p=0.028). Radiation-induced ulcers healed more rapidly (6 weeks) than those of diabetic or arterial origin (16 weeks) and autoimmune origin (24 weeks), with a statistically significant difference (p=0.005). Our results align with those described by Schindl et al.

We used an LED device with a polychromatic light therapy system combining 5 colors from visible to infrared (blue, yellow, red, and infrared) rather than monochromatic. Venous ulcers were the most frequent in our study (43.5%). After LED use, a significant reduction in ulcer diameter and a 72% pain regression were observed. Indeed, LED improves chronic inflammation and pain by inducing a disturbance in nociceptive transfer along C fibers [6]. This light therapy source, applied as monotherapy for the healing of leg ulcers of various origins (arterial, prolidase deficiency, protein C deficiency, post-traumatic wound on burn scar), was associated with an encouraging process of ulcer closure.

Phototherapy is widely used to treat wounds of various etiologies since Mester et al reported that low-intensity laser treatment or LED had a stimulating effect on wound healing [7,8]. Some in vivo and in vitro studies have demonstrated that phototherapy treatments with different optical sources of low-energy photons, such as low-power light laser, improve wound healing [9,10]. However, others could not demonstrate that low-power laser phototherapy promotes wound healing [11]. Our study showed that polychromatic LED used as monotherapy promotes the healing of chronic leg ulcers (of venous or other origin), particularly for small-sized ulcers. Lunderber et al demonstrated the effectiveness of polychromatic polarized low-intensity light on leg venous ulcers by combining visible (480-700 nm) and infrared (700-3400 nm) wavelengths. They suggest that the combination of multiple wavelengths leads to a better photoreceptive response by inducing metabolic events at different cellular levels [12]. Thus, one of the mechanisms of photostimulation is the absorption of visible light energy by the mitochondria, leading to an increase in cellular energy and the activation of DNA synthesis essential for wound healing [11]. The second mechanism is achieved by the infrared part of the light spectrum, initiating a response at the membrane level, probably through photophysical effects on calcium channels [13].

It has been demonstrated that low-power laser light stimulates the release of growth factors by irradiated cells [14]. Growth factors stimulate angiogenesis, production, and degradation of the extracellular matrix, and the release of cytokines. Key cells in the contraction of skin ulcers and collagen synthesis are fibroblasts and keratinocytes. Several studies have demonstrated their action and proliferation in response to low-energy photon stimulation [15].

Another mechanism that could be responsible for the therapeutic effect of phototherapy is local peripheral vasodilation, which can improve skin blood flow and oxygen supply to the ulcer area, thus facilitating the transport of nutrients necessary for ulcer healing [16].

However, our study has biases due to the small number of patients. Further studies with control groups and a larger number of patients are necessary to confirm the effectiveness of polychromatic LED on chronic ulcers of various etiologies.

5. Conclusion

Chronic leg ulcers are debilitating conditions that pose a complex challenge for physicians. Underlying conditions such as diabetes, venous or arterial diseases, or chronic infections are generally implicated in delayed healing. Chronic leg ulcers have garnered interest among dermatologists regarding their management. LED therapy is non-invasive and well-tolerated. Results concerning the healing process and the ability to reduce pain in chronic leg ulcers with polychromatic LED treatment, combining multiple colors (various wavelengths) from visible to infrared, are promising. Each color has effects on specific types of cells, and the dosage used is crucial. The effects of different colors complement each other, highlighting the importance of color combination.

Our study demonstrated that polychromatic LED used in monotherapy improves the healing of chronic leg ulcers of various etiologies (venous, arterial, metabolic, post-traumatic) and reduces the accompanying pain. Larger-scale studies are needed to confirm the effectiveness of polychromatic LED in patients with chronic leg ulcers and to establish practical usage recommendations.

References

1. Grynberg Laloum E, Senet P.Ulcères de jambe. EMC-Traité de Médecine Akos 2015 ;10(1) :1-10
2. Noé, C., Pelletier-Aouizerate, M., & Cartier, H. (2017, April). LED en dermatologie. In *Annales de Dermatologie et de Vénéréologie* (Vol. 144, No. 4, pp. 301-314). Elsevier Masson.
3. De Freitas, L. F., & Hamblin, M. R. (2016). Proposed mechanisms of photobiomodulation or low-level light therapy. *IEEE Journal of selected topics in quantum electronics, 22*(3), 348-364.
4. Le Duff, F. C., Fontas, E., Cazals, N. E., Guardoli, D., Lacour, J. P., & Passeron, T. (2017, December). Stimulation des phénomènes de cicatrisation cutanée par les LED: étude contrôlée comparative de recherche des paramètres optimaux (Étude HeaLED). In *Annales de Dermatologie et de Vénéréologie* (Vol. 144, No. 12, pp. S66-S67). Elsevier Masson.
5. Schindl, M., Kerschan, K., Schindl, A., Schön, H., Heinzl, H., & Schindl, L. (1999). Induction of complete wound healing in recalcitrant ulcers by low-intensity laser irradiation depends on ulcer cause and size. *Photodermatology, photoimmunology & photomedicine, 15*(1), 18-21.
6. Vitoriano, N. A. M., Mont'Alverne, D. G. B., Martins, M. I. S., Silva, P. S., Martins, C. A., Teixeira, H. D., ... & Tatmatsu-Rocha, J. C. (2019). Comparative study on laser and LED influence on tissue repair and improvement of neuropathic symptoms during the treatment of diabetic ulcers. *Lasers in medical science, 34,* 1365-1371.
7. Mester, E., Mester, A. F., & Mester, A. (1985). The biomedical effects of laser application. *Lasers in surgery and medicine, 5*(1), 31-39.
8. 8. Mester, E., Spiry, T., Szende, B., & Tota, J. G. (1971). Effect of laser rays on wound healing. *The American Journal of Surgery, 122*(4), 532-535.
9. Lyons, R. F., Abergel, R. P., White, R. A., Dwyer, R. M., Castel, J. C., & Uitto, J. (1987). Biostimulation of wound healing in vivo by a helium-neon laser. *Annals of plastic surgery, 18*(1), 47-50.
10. Schindl, A., Schindl, M., & Schindl, L. (1997). Successful treatment of a persistent radiation ulcer by low power laser

therapy. *Journal of the American Academy of Dermatology, 37*(4), 646-648.
11. Karu, T. (1989). Photobiology of low-power laser effects. *Health physics, 56*(5), 691-704.
12. Lundeberg, T., & Malm, M. (1991). Low-power HeNe laser treatment of venous leg ulcers. *Annals of plastic surgery, 27*(6), 537-539.
13. Smith, K. C. (1991). The photobiological basis of low level laser radiation therapy. *Laser Therapy, 3*(1), 19-24.
14. Slavin, J. (1995). Fibroblast growth factors: at the heart of angiogenesis. *Cell biology international, 19*(5), 431-444.
15. Yu, W., Naim, J. O., & Lanzafame, R. J. (1994). The effect of laser irradiation on the release of bFGF from 3T3 fibroblasts. *Photochemistry and photobiology, 59*(2), 167-170.
16. Steinlechner C, Dyson M. (1993). The effects of low-level laser therapy on proliferation of keratinocytes. (5),65-73