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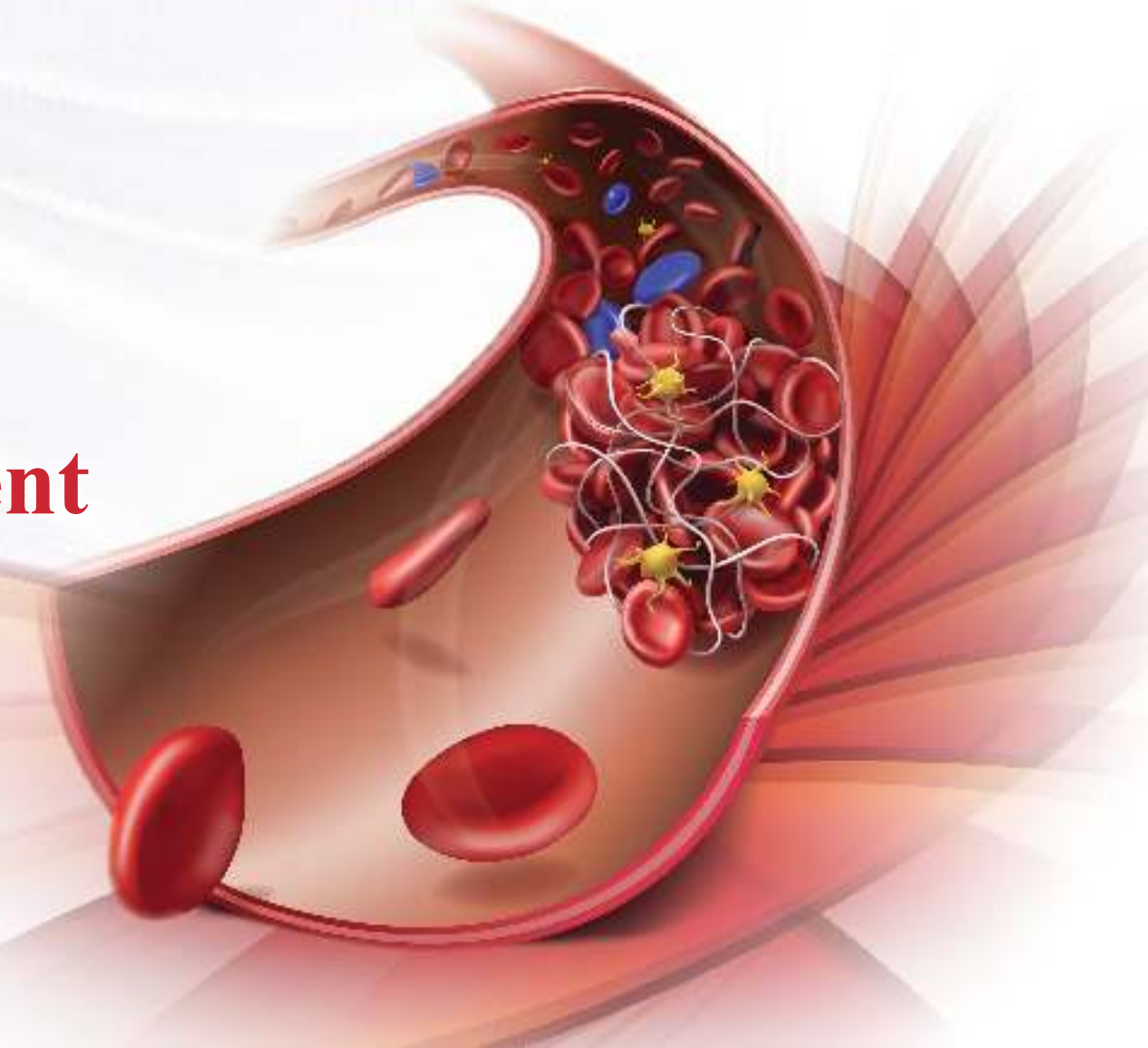

Phototherapy in Management of Diabetic Foot Ulcers:
Reality and Illusion

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Introduction

- One of the most common complications of diabetes mellitus is the diabetic foot syndrome.
- The diabetic foot ulcer is one of the most prevalent causes of nontraumatic limb amputations.
- Diabetic foot problems have a significant financial impact on the national health system and on patients' quality of life.
- Since current therapies are variable in their ability to induce complete healing, there remains a need to develop adjunctive treatments that can improve or accelerate the healing process in diabetic foot ulcers.
- Low-level laser therapy (LLLT) has been suggested as a promising treatment option for open wounds.

Classification of Diabetic Foot Ulcers

The Wagner Ulcer Classification System for Classifying Diabetic Foot Ulcers

Grade 0
Pre-ulcerative area without open lesion

1
Superficial ulcers that may penetrate to the dermal tissue

2
Deep ulcers (reaching ligaments, tendons, joint capsules, or bones) but without abscess or osteomyelitis

3
Deep ulcers complicated by the presence of an abscess, osteomyelitis, or joint sepsis

4
Localized gangrene involving part of the toe or heel

5
Global foot gangrene

Pay more attention to the wound condition. If it worsens, it would be better to return to the doctor as soon as possible.

Risk Factors:

- Peripheral neuropathy (sensory, motor, and autonomic).
- Peripheral arterial occlusive disease.
- Limited joint mobility.
- Foot deformation.
- Improper footwear.

Conventional Treatment Methods

- Different kinds of wound cleaning & debridement.
- Skin grafting.
- Antibiotics.
- Vasodilators.
- Pain management.
- Different types of bandages.
- Fly maggots.

Low Level Laser Therapy (LLLT)

- Non□invasive, and pain□free treatment method, which promotes the ulcer repair process through multiple mechanisms such as increased cell growth and vascular activity.
- It is called soft laser and is known to supply direct bio stimulative light energy to body cells.
- The absorbed laser energy stimulates molecules and atoms of cells but does not cause rapid or significant increase in tissue temperature.

- Most LLLT devices illuminate the treatment area from a certain distance.
- Laser needles are not needles and not inserted into the skin; optical light fibers are fixed on the acupuncture points in an upright position. Thus, a high optical density can be achieved at the end of the fiber, minimizing light scattering that occurs at the surface of the skin.

Types of LASER

- Different laser wavelengths have different depths of penetration into human tissue (2-3 cm):

  Red laser (685 nm) has a deeper penetration depth than violet, blue(405 nm), green, or yellow.

Advantages

- **Blue light** Reduces the microbial load in diabetic ulcers without inducing bacterial resistance so demonstrated efficacy against antibiotic-resistant strains.

A low-power laser (415 nm) has a direct antibacterial effect on S. Aureus and E. Coli

➢Red light

- **Accelerates healing:** it facilitates the recovery of mitochondria inhibited by Nitric Oxide gas by release of NO from mitochondrial complexes, so improves wound healing via the NO pathway by inducing endothelial cell migration by activating growth factors.
- **Reduces inflammation** by inhibition of prostaglandines, interleukins and cytokines.
- **Improves perfusion** by release of nitric oxide from nitrosyl complexes with haemoglobin, so enhance epithelialization.


Patients usually do not feel the beginning of the treatment, but 5–10 minutes later many patients report a pleasant warmth and sometimes vibrating feeling in some treated areas.

Hindawi Publishing Corporation
Evidence-Based Complementary and Alternative Medicine
Volume 2014, Article ID 626127, 9 pages
http://dx.doi.org/10.1155/2014/626127

Review Article

Low Level Laser Therapy for the Treatment of Diabetic Foot Ulcers: A Critical Survey

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Received 14 October 2013; Revised 10 January 2014; Accepted 19 January 2014; Published 16 March 2014

Academic Editor: Jaung-Geng Lin

- In a double-blind randomized placebo-controlled study, the healing effect of combined 660 and 890 nm laser treatment on 23 diabetic leg ulcers was tested by Minatel et al.

  Mean ulcer granulation and healing rates were significantly higher in the treatment group than in the placebo group at each of 15, 30, 45, 60, 75, and 90 days of treatment.

Treatment of Chronic Lower Extremity Ulcers with A New Er:Yag Laser Technology

Alcolea JM [1,7], Hernández E [2], Martínez-Carpio PA [3,7], Vélez M [4,7], Khomchenko V [5], Sola A [6], Trelles MA [7*]

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Concerning the reduction of the ulcer area at the end of the treatment, 5 patients (18,75%) presented a reduction of under 25%; 4 patients (25%) had a reduction between 25-50%; 2 patients (12,5%) presented a reduction in the ulcer area between 50-75%; 4 patients (25%) presented a reduction greater than 75%, and 3 patients (18,75%) had a complete closure of the ulcer **(Fig. 5-11)**. The final area of the ulcer was reduced to 7.8 ± 7.5 cm^2 in the 13 patients who did not achieve a complete reduction of the lesion. The treatment managed to reduce pain as well as the ulcer area, while the bleeding increased. These parameters were statistically significant ($p=0.05$), on the Student's t-test for the comparison of averages.

Results

The results are expressed as the mean plus standard deviation, taking into account that 2 patients did not complete the study. The average length of the ulcers along the main axis was 6.7 ± 2.1 cm before beginning the treatment, with an initial average area of 15,7 ± 8.4 cm^2 (r=4 – 36). On the scale from 1 to 10 (1 no pain, 10 maximum pain), at the beginning of treatment patients reported an average of 4.4± 1.6 points (r=2 – 8). At the end of treatment patients reported their pain more than 2 points lower on the scale, with an average of 2.3 ± 1.3 points (r=0 – 5).

Regarding the bleeding, measured on the scale from 1 to 10, an increase in the signs of bleeding was observed matching the progress of the number of laser sessions. At the beginning of the treatment, patients presented bleeding of 3.1 ± 1.4 on average (r=1 – 6) and the result at the end of treatment was 6.3 ± 1.3

Original Article

The Effect Of Combined 650 Nm And Infrared Laser On Chronic Diabetic Foot Ulcer Surface Area: A Randomized Controlled Trial

Heidy Fouad Ahmed Esmael[1*], Mahmoud S. El Basiouny, PhD [2], Mona Ibrahim Morsy, PhD [2], Hala Ahmed el Sayed Abdel Gawad, PhD [3] Alaa Abdelraheem Hssein [4], Tamer Ezzat Abdallah[5]

- 45 patients with an age range from 18-60 years old, both sexes, were assigned randomly into three equal groups, each group consisting of 15 patients, **group A received laser therapy** in sequential mode, group B received laser therapy in **separate mode** the control group C receive traditional wound care.
- The primary outcomes were the wound surface area measurement, percentage of wound complete closure and percentage of days needed for surface area reduction before and after receiving the treatment protocol for two consecutive months, and the secondary outcomes were percentage of wound cause and location frequencies.

Results

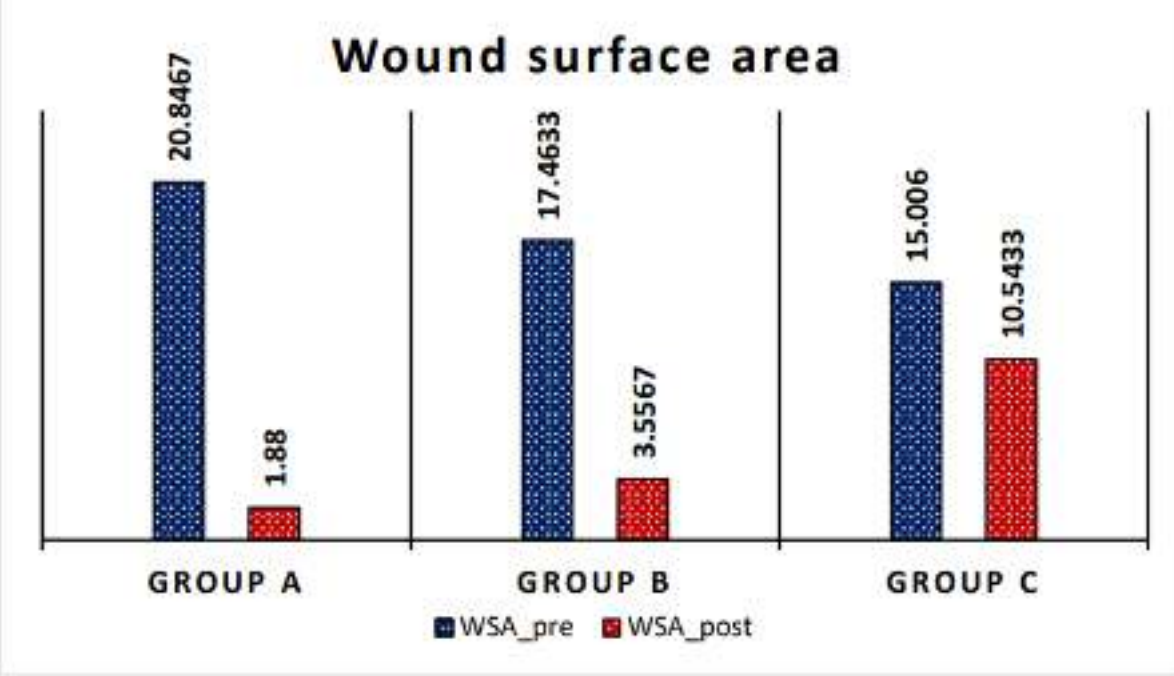

Figure 3. Mean values of WSA before and after treatment in study groups.

ble (2) Pairwise comparison between test groups regarding Days of recovery and WAS.

Groups	Group type	WSA after treatment (p-value)	Days of recovery (p-value)
Sequential group	Separate group	0.361	0.093
Sequential group	Control	0.002**	0.041**
Separate group	Control	0.008**	0.438

** Significant at 0.05.


3 weeks

The Illusion – Myths and Misconceptions

- Phototherapy is a standalone treatment: but it should be part of a comprehensive treatment plan that includes wound debridement, infection control, offloading pressure from the ulcer, and managing underlying conditions like diabetes.
- Immediate results are expected: but it requires multiple sessions to show significant improvement.
- All phototherapies are the same: there's a misunderstanding that all light therapies, like low-level laser therapy (LLLT) and ultraviolet (UV) light therapy, work in the same way. In reality, different wavelengths and types of light have different mechanisms and effects, and their efficacy can vary depending on the specific characteristics of the ulcer and the patient.

- Phototherapy Has No Risks: Some patients and clinicians believe that phototherapy is entirely risk-free. While generally safe, there can be risks, such as skin irritation, burns, or damage to surrounding healthy tissues, especially if the therapy is not administered correctly.
- Phototherapy Replaces Standard Wound Care: it should complement standard care procedures like dressing changes, wound cleaning, and glycemic control.
- One-Size-Fits-All Approach: Some assume that phototherapy will be equally effective for all DFU patients. In reality, patient-specific factors like ulcer severity, presence of infection, and overall health can influence the effectiveness of phototherapy.

Conclusion

- The red and infrared lasers in general are efficient collaborators in the repair of skin wounds, inducing growth of fibroblasts, collagen synthesis, angiogenesis, and subsequent re-epithelialization to wound closure.
- The combination of red and infrared wavelengths influence the percent of wound closure and also the number of days needed for complete wound closure as red laser activate the photoreceptors that absorb the infrared lasers and produce more ATP needed for wound repair.
- The available studies about LLLT as a treatment method for diabetic ulcers give positive results and encourage further investigations.


Thank You
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