Integrated new therapy to usual care in management of not healing wounds and post-surgical ulcers.

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INTRODUCTION

Managing foot ulcers in diabetes pose significant challenges and financial burdens on healthcare systems, and impact morbidity, mortality, and quality of life.

In light of this, wound management principles such as debridement and wound bed preparation, alongside novel technologies, designed to alter wound physiology for facilitating healing, are essential when attempting to heal a chronic diabetic foot ulcer. [1-2]

If Standard Care remains a target of our actions, novel methods and therapies may improve outcomes.

Particular attention should be given to post-surgical lesions that do not heal in the first instance.

Advanced medications, skin grafting (autologous, engineered or from a cadaveric donor), and physical therapies are available to enhance tissue regeneration, each with its own mechanisms. At the San Jacopo Hospital DF UNIT in Pistoia (Italy), we use the following integrated protocol to improve wound healing in various conditions:

- Surgical treatment (debridement, minor amputations, evacuation of abscesses)
- Standard treatment of infections (antibiotic therapy, antiseptics)
- Vascular access (diagnosis and possibly revascularization) to improve blood flow.

Finally, we are trying to improve outcomes with some new approaches such as Vacuum Assisted Closure Therapy (VAC) and physical therapies.

Among physical therapies for treating of diabetic foot ulcers, laser therapy has demonstrated potential and promising outcomes. [3-6]

The Multiwave Locked System (MLS®) Laser Therapy is well known for its capacity to allow analgesic, antiinflammatory, anti-oedema and tissue repair effects in superficial and deep tissues through cellular and molecular mechanisms demonstrated in studies conducted with in vitro and animal models. [7, 8, 9]

Based on the literature concerning the mechanisms of action of MLS® technology and its specific features, we have ascertained its appropriateness, for addressing patient issues, within our department.

MATERIALS AND METHODS

We have collected three different clinical cases in which MLS® Laser Therapy applied by a M8 device (ASA Srl, Italy) was used as an adjuvant treatment to our integrated protocols for improving wound healing in the treatment of foot ulcers in diabetic patients.

The MLS® - M8 Laser is a class IV laser therapy system that allows the emission of near-infrared (NIR) beams with wavelengths of 808 nm - 905 nm, spatially overlapped and synchronized, with continuous (or frequenced) and pulsed emission respectively, average power of 3.5W and a peak power of 75W.

The device is designed with a robotic head that allows automatic scanning of the anatomical area to be treated with homogenous energy delivery over a target area from 20 cm^2 to 900 cm^2.

During each session, two distinct laser treatments were administered covering an area of 20 cm^2.

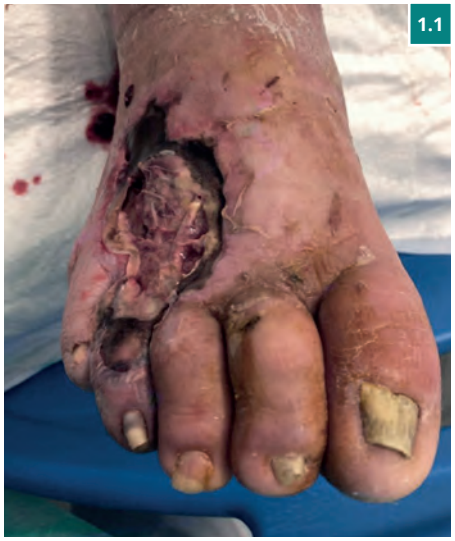
The first treatment aimed to induce an anti-edema effect through modulation of inflammation and improvement of endothelial function, whereas the second treatment was designed to have a biostimulating effect to modulate the tissue healing. Please refer to the following table for the specific parameters utilized.

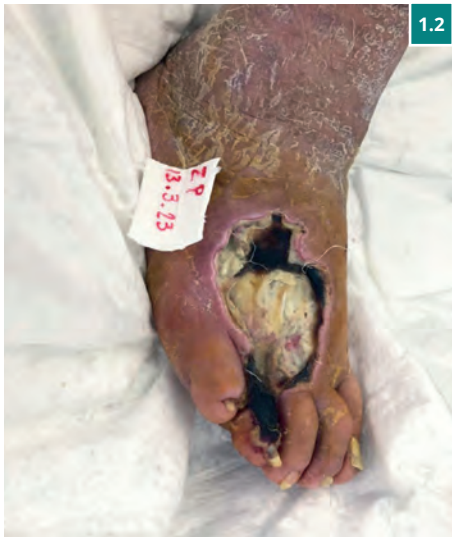
Treatments	Modulation	Frequency (Hz)	Intensity (%)	Dose (J/cm²)	Treatment time (min:sec)
1	FPW*	2000	100	10	01:33
2	FPW*	1500	100	2	00:20

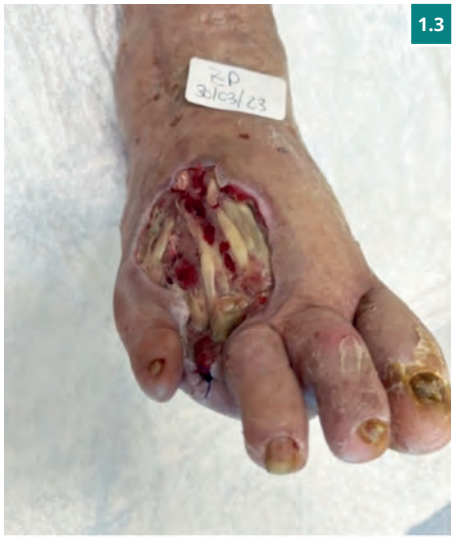
(*) FPW – Frequenced Wave: the 808 nm wavelength is emitted in a frequenced modality, combined, and synchronized with the 905 nm wavelength emitted in a pulsed modality.

CASE REPORT 1

In March 2023, a 62-year-old male patient with newly diagnosed type 2 diabetes (HbA1c 12.8%, bad metabolic control) and peripheral vascular disease came to our clinic. Upon examination, a foot abscess accompanied by critical limb ischaemia was diagnosed (Figure 1.1 and 1.2). Treatment started with abscess evacuation, and two days later, right leg femoral and anterior tibial artery angioplasty was performed. The post-operative lesion on the outer surface of the right foot was still present after two weeks and showed slow healing and slow tissue regeneration (refer to Figure 1.3). After two weeks, the patient started to receive MLS® Laser Therapy twice a week to facilitate the formation of an optimal lesion bed for a subsequent scheduled skin graft from a cadaver donor. (Refer to Figure 1.4, 1.5). Following skin grafting procedure (Figure 1.6), in addition







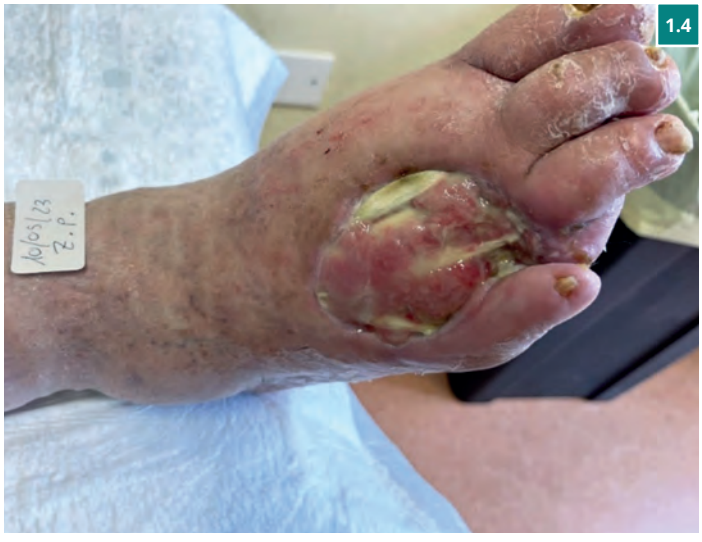


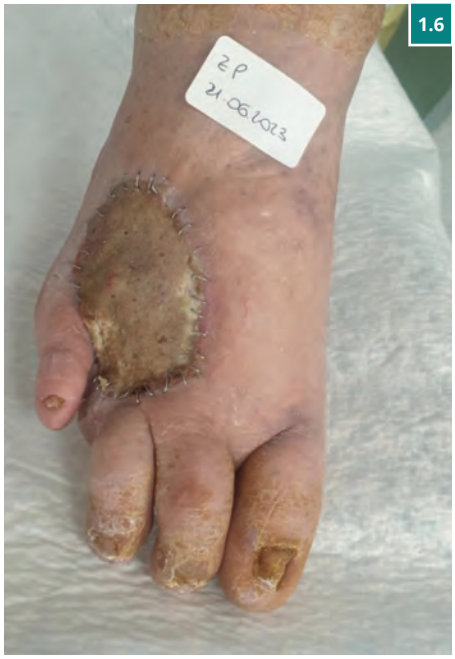
Figure 1.1, 1.2, 1.3: Evolution of the lesion during the hospitalisation; after more than 3 weeks, the wound showed a slow evolution in terms of tissue regeneration.

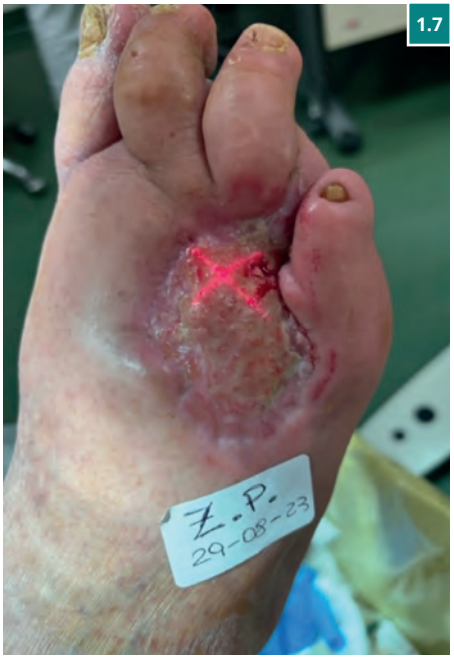
Figure 1.4, 1.5: Wound evolution during laser therapy for lesion bed preparation prior to skin grafting procedure.

to standard wound care laser therapy was continued . At each session the two specific treatment protocols previously described were applied to the lesion area to stimulate edema resorption and healing mechanisms. The treatments were performed with a fixed pointer and with doses of 10 and 2 J/cm^2, respectively.

After sixty-nine days from the skin grafting procedure and eighteen laser sessions, the treatment results were very satisfactory, the post-operative lesion was in an excellent state of development and showed clear re-epithelialisation signs.

(Figure 1.7)





Figures 1.6, 1.7: Lesion after skin grafting and at the end of the evaluation.

CASE REPORT 2

On March 15th, 2023, a 48-year-old female patient , had access to emergency department (ED) for wet gangrene of the left foot and glycemic decompensation in newly diagnosed diabetes mellitus (HbA1c 15.5% and no other chronic complication of diabetes) (see Figures 2.1, 2.2). We performed excarectomy, evacuation of a dorsal abscess and initial forefoot plantar fasciitis and IV toe amputation. The patient underwent intravenous antibiotic therapy and local antiseptic dressings. Following reduction of clinical signs of infection, the negative wound pressure therapy (NWPT) was applied. (Figure 2.3)

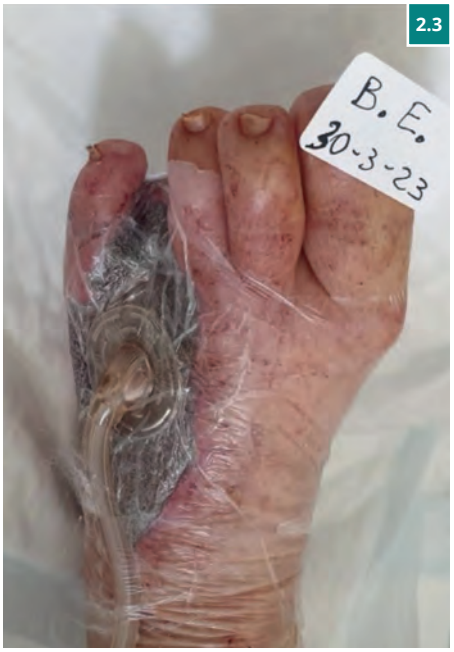
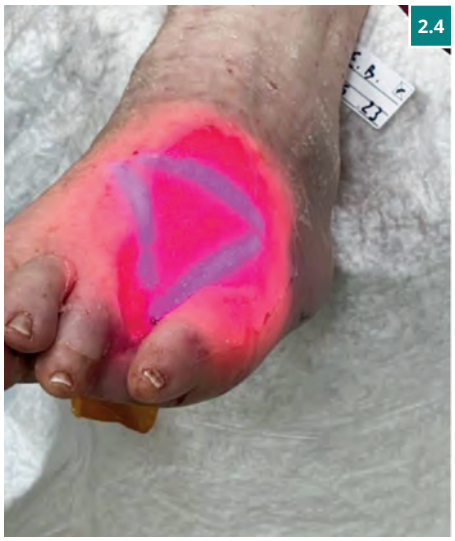


Figure 2.1,2.2, 2.3:
Left and central photos show the left foot gangrene at ED. Right photo shows the NWPT: a specific dressing was placed over the wound and connected to a vacuum pump. The negative pressure removes the excess exudate, increases blood flow, and promotes the growth of healthy tissue.

Every 4 days, for three weeks, the patient underwent MLS® Laser Therapy, dressing change and NPWT re-application, to prepare the lesion bed for skin grafting. At each session specific treatment protocols were applied to the lesion area to stimulate edema resorption and healing mechanisms. The treatments were performed with a fixed pointer and with doses of 10 and 2 J/cm^2, respectively. There were increasing signs of wound bed granulation as treatment progressed. (Figure 2.4 & 2.5)



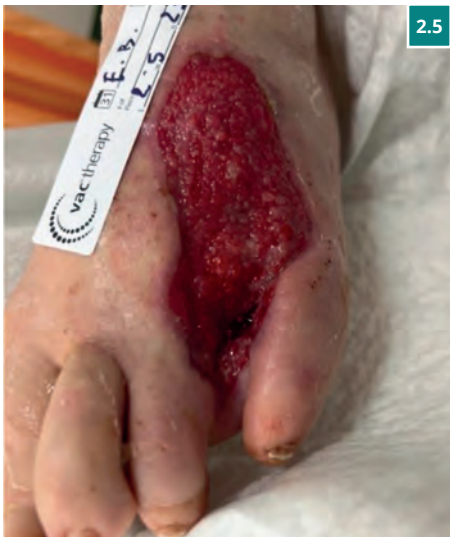


Figure 2.4, 2.5: Lesion bed preparation with MLS® Laser Therapy.

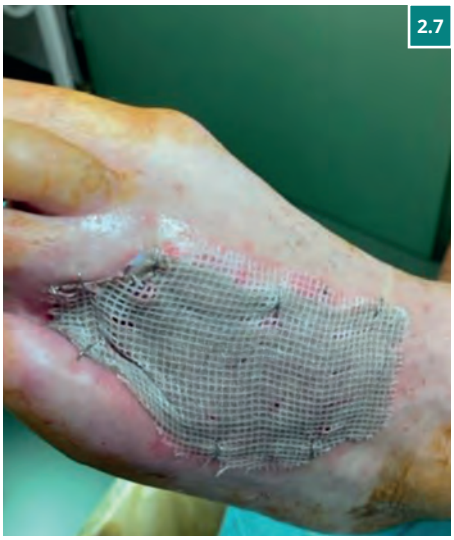


Figure 2.6, 2.7: lesion condition before and immediately after skin grafting, wound area (~8cm x 2cm).

After forty days from the beginning of NWPT therapy and eleven MLS® laser sessions, the patient underwent to skin grafting from cadaveric donor. (Figures 2.6, 2.7)

Subsequently, every four days during dressing change, the area of the lesion and the surrounding tissue were treated with MLS® Laser Therapy using the protocols described above.

As the patient received laser therapy alongside standard treatments, objective improvements were recorded. These included a notable and progressive acceleration of wound healing and clear signs of re-epithelialisation. (Figure 2.8, 2.9).

The efficacy of the therapy is based on its ability to improve the condition of the wound prior to tissue transplantation and to accelerate the healing process.

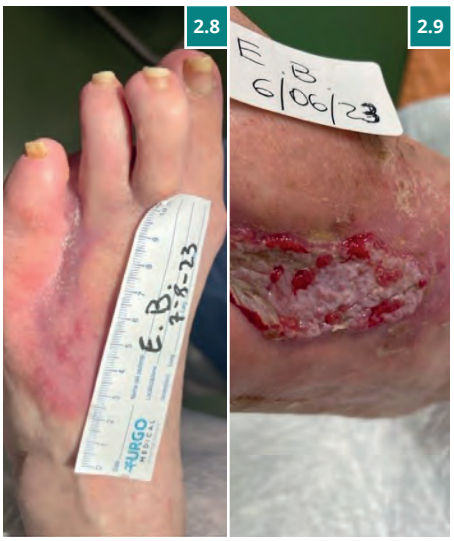


Figure 2.8, 2.9:
The images show the post-operative lesion during the laser therapy and at the final evaluation - complete healing of the wound.

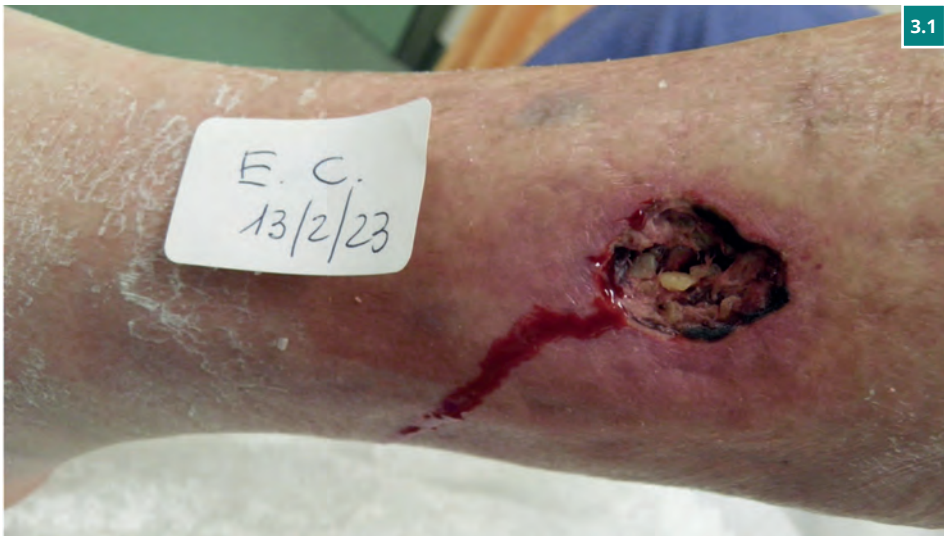
CASE REPORT 3

In February 2023, a 77-year-old male with type 2 diabetes (diabetes duration 37 years), peripheral vascular disease, chronic kidney disease and laser treated retinopathy, came to our clinic. After experiencing a blunt trauma to the middle third of his left lower limb, a lesion emerged and quickly progressed into an abscess with an intramuscular fistulous tract. The patient underwent evacuation of the purulent material and toilet of the lesion while receiving antibiotic therapy. Following this, in addition to standard wound care, a session of MLS® Laser Therapy, with the two specific protocols previously described, was administered every 3 days for a total of 10 sessions.

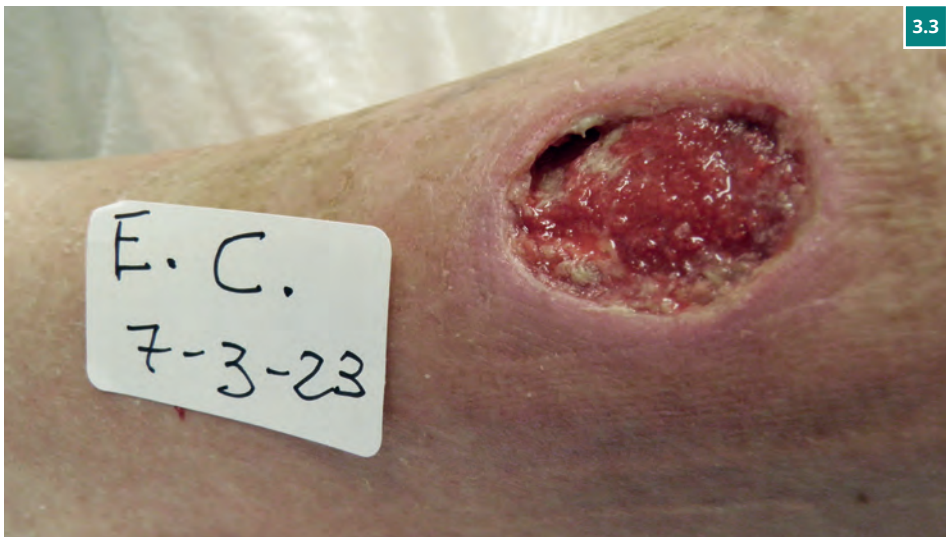
In the meantime, the patient underwent concurrent angioplasty for the superficial femoral artery and peroneal trunk in the left lower limb.

The progression of the lesion from initial examination to final assessment is shown in the images below. (Figures 3.1-3.5; Table 1). A rapid closure and re-epithelialization of the lesion was noted.

DATE	DAYS	Lesion Area (cm^2)	Lesion Depth (cm)	Lesion Volume (cm^3)	Area Reduction since Baseline (%)	Volume Reduction since Baseline (%)
13 Feb 2023	0	20 (5cmx4cm)	1.5	30	-	-
24 Feb 2023	11	16 (4cmx4cm)	0.5	8	20 %	73 %
07 Mar 2023	22	12 (4cmx3cm)	0.2	2.4	40 %	92 %
20 Jul 2023	157	0	0	0	100 %	100 %



3.1



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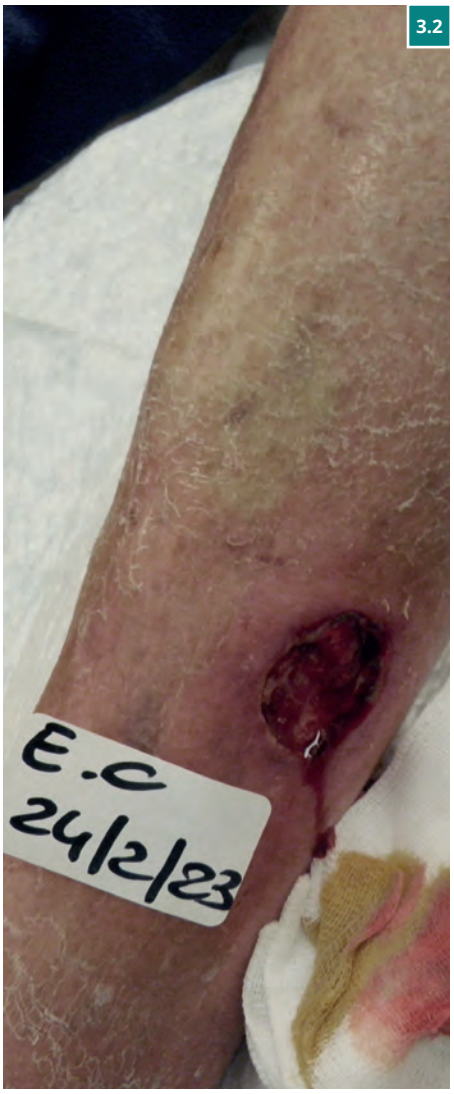


3.2

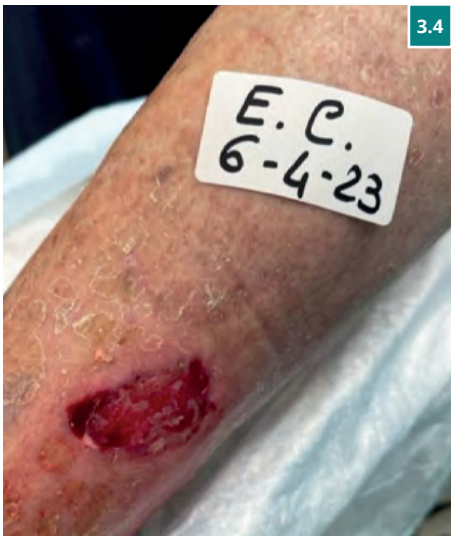
DISCUSSION AND CONCLUSIONS

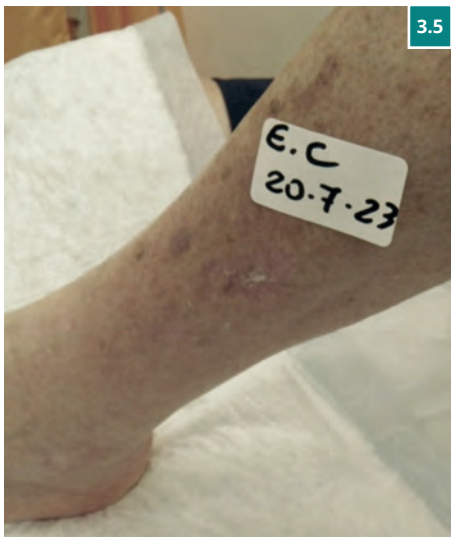
Based on our clinical experience, the integration of guidelines based standard wound with innovative therapeutic methods like MLS® Laser Therapy has demonstrated remarkable efficacy in enhancing and accelerating the wound healing process. Specifically, its role in achieving an ideal wound bed for cadaveric tissue transplantation has been noteworthy.

Notably, in the aforementioned cases, the expected healing time was significantly reduced. These outcomes are in agreement with the results of *in vitro* studies aimed at investigating the mechanisms underlying the therapeutic effects of the MLS® laser source.

These studies demonstrated that MLS® emission is capable of promoting neoangiogenesis, improving cell energy metabolism, modulating inflammation and, consequently, regulating fibroblast activation [9, 10]. The therapy offers additional benefits because of its easy-to-use application and reduced treatment time compared to traditional methods. The findings here presented show the potential of this therapy and establish a sound basis for future research.

Figures 3.1, 3.2, 3.3, 3.4, 3.5:
Progressive healing of the ulcer.





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