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A case series study - treatment of chronic wounds with Erbium:YAG laser

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Abstract

The objective of this case series was to evaluate the effectiveness and safety of Erbium:YAG (Er:YAG) laser therapy, using both ablative and RecoSMA stimulation modes, in treating Chronic Lower Extremity Wounds (CLEWs).

This prospective single-center case series included 24 patients (20 completed the study) with chronic wounds of venous, arterial, or mixed etiology. Patients with arterial or mixed CLEWs received an alginate wound dressing containing antimicrobial silver. Those with venous ulcers additionally received compression therapy using the UNNA BOOT. All patients underwent weekly sessions combining ablative Er:YAG debridement and RecoSMA stimulation. Outcomes included time to complete epithelialization, reduction in wound area, and adverse events. Wound area was measured using digital planimetry with standardized photographic documentation.

Twelve patients achieved complete wound epithelialization (mean healing time: 4.5 weeks, Standard Deviation, SD, 3.8), two had partial improvement, and six showed no significant change. No adverse events were reported. Statistical analysis showed no significant correlation between healing outcomes and common risk factors such as age, diabetes, obesity, or stasis dermatitis.

Combined Er:YAG laser debridement and biostimulation with RecoSMA is a safe and promising adjunct

therapy for CLEWs, promoting healing without the need for anesthesia. Further randomized controlled trials are warranted to validate long-term efficacy.

Key words: lower extremity ulcers, wound healing, debridement, chronic wounds, RecoSMA, Erbium:YAG laser.

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Introduction

Chronic Lower Extremity Wounds (CLEWs) have a high prevalence and affect up to 49 million people worldwide each year, resulting in significant morbidity, mortality, and healthcare costs. The cumulative lifetime risk of developing these wounds is between 1.0% and 1.8%.[1]

The pathogenesis of CLEWs is variable, although it is accepted that 90% are of venous origin, 6% ischaemic, 3% mixed (arterial and venous), and the remaining 1% is attributed to other causes.[2] Traditional wound care, including eliminating refluxes in superficial veins and compression therapy for venous ulcers, arterial reconstruction for ischemic ones, and sharp or enzymatic debridement, are still regarded as the cornerstone of management. However, these techniques may be limited by patient tolerance, pain, or risk of secondary infection. Most patients with chronic wounds require periodic wound debridement, which requires adequate anesthesia. This necessitates proper equipment and facilities, as well as trained medical staff. It can be challenging to achieve, especially with outpatient patients who have comorbidities.

Laser therapy with Erbium:YAG laser, operating at a wavelength of 2940 nm, offers an advantage for ablating devitalized tissue with minimal thermal damage. The laser's high water absorption coefficient allows precise superficial debridement and may promote angiogenesis, making it a potentially ideal tool for chronic ulcer care. With each application, the Er:YAG laser raises tissue temperature above 300°C.[3] This rapid heating causes intracellular water to vaporize explosively, leading to the expulsion of carbonized debris from the wound bed, while avoiding the formation of a necrotic eschar. Short pulses of the laser also generate mechanical stress waves, which spread outward from the irradiated zone into adjacent tissues. The resulting resonance within deeper layers beneath the ulcer is thought to promote regenerative processes that support wound healing.[4] The method allows for wound debridement without the need for anesthesia. Combined with a stimulation regimen, it can convert the wound from chronic to acute, accelerating its healing.

Materials and Methods

Patient selection

The case series single center study was conducted in the Department of Vascular Surgery at the Shaare Zedek Medical Center in Jerusalem, Israel. The study period ran from December 2024 to April 2025. Patients with chronic wounds who visited the outpatient departments were assessed, and information about the study was provided to them. Patients who provided written consent for the publication of their data and photographs were enrolled in the study. Twenty-four (24) patients signed up for the study and 20 completed it. The gender distribution was as follows: 9 women and 15 men with an average age of 64.0 years (Standard Deviation, SD, 15.9; 32-89). Twelve patients presented venous ulcers, four arterial ischemic wounds and five patients had mixed ulcers. All patients had previously received multiple topical treatments without success. All the ulcers lasted for at least 3 months. The average area of the wounds was as 595.8 mm^2 (SD 823.9; 18-3552).

The inclusion criteria were the provision of a signed and dated informed consent form, and a stated willingness to comply with all study procedures and availability for the duration of the study.

The exclusion criteria were: i) active wound infection (ASEPSIS Score >20); ii) pre-existing conditions - evidence of gangrene on any part of affected limb infection at time of screening, active Deep Vein Thrombosis (DVT), active malignancy, anemia (Hb<9 gr/dL); iii) known allergies to dressing materials, including occlusive dressings and the adhesives on such dressings; iv) taking immunosuppressive medication and growth factor therapy; v) pregnant at the time of screening.

Laser parameters

An Er:YAG laser system (Multiline laser system, LINLINE MS, Riga, Latvia) was used. Laser treatment was used as two consecutive treatments. First, debridement was performed with ablative mode (21.2 J/sm^2, short pulse duration, 1 Hz) at 2936 nm wavelength, spot size was 3 mm, pulse frequency 3 Hz. Immediately thereafter, treatment in stimulation mode was performed. The Reconstructive Spatially Modulated Ablation,

Linline Medical Systems (RecoSMA) technology was used, which combines a laser doped with Erbium and Yttrium-Aluminum Garnet (Er:YAG), which operates at a wavelength of 2,936 nm, and has a special SMA nozzle. Stimulation was performed with RecoSMA (5.6 J/sm^2, short pulse duration, 1 Hz) at 2936 nm wavelength, spot size was 3 mm, pulse frequency 3 Hz. Stimulation was performed both directly on the tissues in the wound and on the tissues 3 cm around the wound (Figure 1). Sessions were performed weekly.

Adjunctive care

Patients with arterial or mixed CLEWs received an alginate wound dressing containing antimicrobial silver. Those with venous ulcers additionally received compression therapy using the UNNA BOOT system.

Endpoints

Primary outcome was time to complete epithelialization. Secondary outcomes included percent reduction in wound area and adverse events.

Data collection

The CLEWs size was measured using digital planimetry. The wounds were photographed at a constant distance of 30 cm under the same lighting conditions. Photographs were taken before the first laser session and then weekly before each treatment. The final photograph was taken after completing the last treatment. The images obtained were converted to DICOM format, which allowed viewing and measuring the wound area in standard programs used in the clinic (Figure 2). In general, the analysis of the images closely matched the visual examination analysis. Data was compiled and entered into an Excel worksheet. Descriptive statistics were calculated, and the Chi-squared test was applied. A p-value of <0.05 was considered statistically significant.

Results

Four patients dropped out of the study: three due to concomitant pathology requiring appropriate treatment and one due to wound deterioration and infection (a poorly healing stump wound after a below-knee amputation due to diabetes mellitus).

In 12 patients, the CLEWs completely epithelialized during the treatment period. The average period of wound healing was 4.5 weeks (SD 3.8; 2-16). In two more patients, the wounds decreased in size. In 6 patients, the wounds did not show a distinct tendency to heal (Figure 3).

The significance of differences in outcomes depending on the impact of risk factors such as age, diabetes mellitus, obesity, and the presence of stasis dermatitis around the ulcer was assessed. Figure 4 shows the chi-square values and significance levels.

In no case was it possible to identify an association between the specified risk factor and wound healing in 14 patients (two patients with good positive epithelialization dynamics included in the overall analysis them).

Discussion

Biofilms often reside deep in necrotic tissue, making fast and effective debridement essential. Various debridement methods include sharp, enzymatic, and others.

At the same time, acute wound debridement requires anesthesia, appropriate personnel, and equipment. Enzymatic and similar wound cleansing methods do not ensure the reliable elimination of necrotic tissue and microbes. From this point of view, Er:YAG laser debridement shows promising results.

In 2025, the results of a randomized clinical trial involving 144 patients with diabetic foot, venous, and arterial leg ulcers were published.[5] The patients and treatment outcomes were similar to those we obtained. The

average percentage reduction in wound area at the end of 30 days was found to be 69% in the treatment group and 53% in the control one.

In 2022, a study was conducted that was broadly similar to ours. This study evaluated outcomes in patients with chronic ulcers treated with a combination of full-field and fractional erbium:YAG laser sessions. Twenty-three patients received treatments, starting with full-field debridement followed by fractional sessions. Complete re-epithelialization at one year was the primary outcome. Healing rates were 69% for arterial, 77.7% for immunologic, 75% for venous, 88.8% for diabetic, and 100% for mechanical ulcers. The combined laser regimen supported wound healing across diverse ulcer etiologies.[6]

In a single-arm trial[7] involving 59 individuals with diabetic ulcers, a two-phase protocol was implemented: first, Er:YAG laser ablation was performed for debridement, followed by biostimulation using spatially modulated RecoSMA technology. Weekly sessions led to a consistent decrease in ulcer size, culminating in the complete healing of all ulcers by the end of the treatment.

A separate discussion is required for the group of patients who did not experience clinically significant improvement. There are patients whose wounds have persisted for years despite adequate treatment. When the wounds heal, they quickly return. There is no doubt that such patients require a more comprehensive approach, including teaching them self-care skills such as wound care, healthy diet, and a physical exercise.[8] This group of patients with treatment-resistant wounds deserves special attention and separate research.

Conclusions

Er:YAG laser debridement performed with ablative mode and stimulation with RecoSMA appears to be a safe, well-tolerated adjunct in the management of CLEWs. Further randomized controlled trials are warranted to establish long-term efficacy.

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Contributions: study conception, KM, JN and IG. All authors contributed to the study design, protocol submission and draft manuscript preparation. All authors reviewed this protocol, approved the final version of the manuscript, and agreed to be held accountable for all aspects of the work.

Conflict of interest: the authors declare no potential conflict of interest.

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Ethics approval and consent to participate: ethical approval was not required for this type of study according to institutional guidelines. Patient data were anonymized, and no additional interventions were performed.

Informed consent: patients with chronic wounds who visited the outpatient departments were assessed, and information about the study was provided to them. Patients who provided written consent for the publication of their data and photographs were enrolled in the study.

Patient's consent for publication: the patients gave their written consent to use their personal data for the publication of this case report and any accompanying images.

Availability of data and materials: all data generated or analyzed during this study are included in this published article.

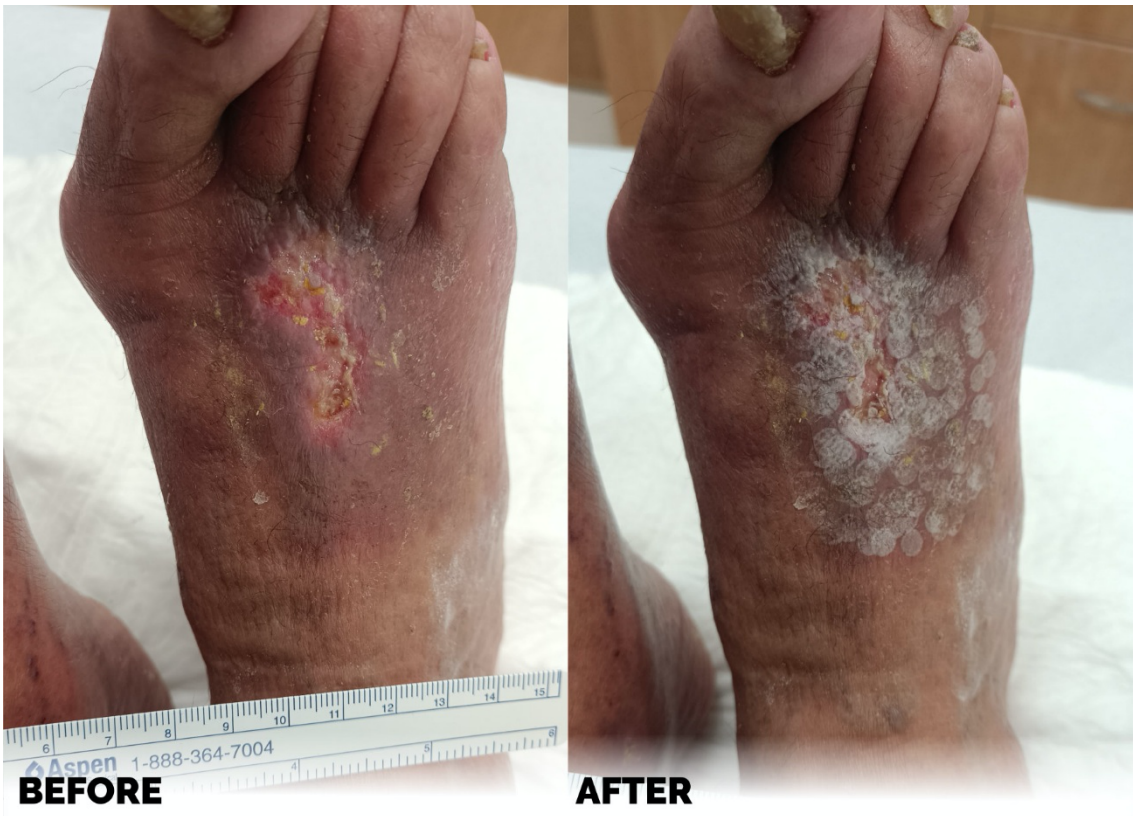

Figure 1. Wound before and after debridement performed with ablative mode and stimulation with RecoSMA.

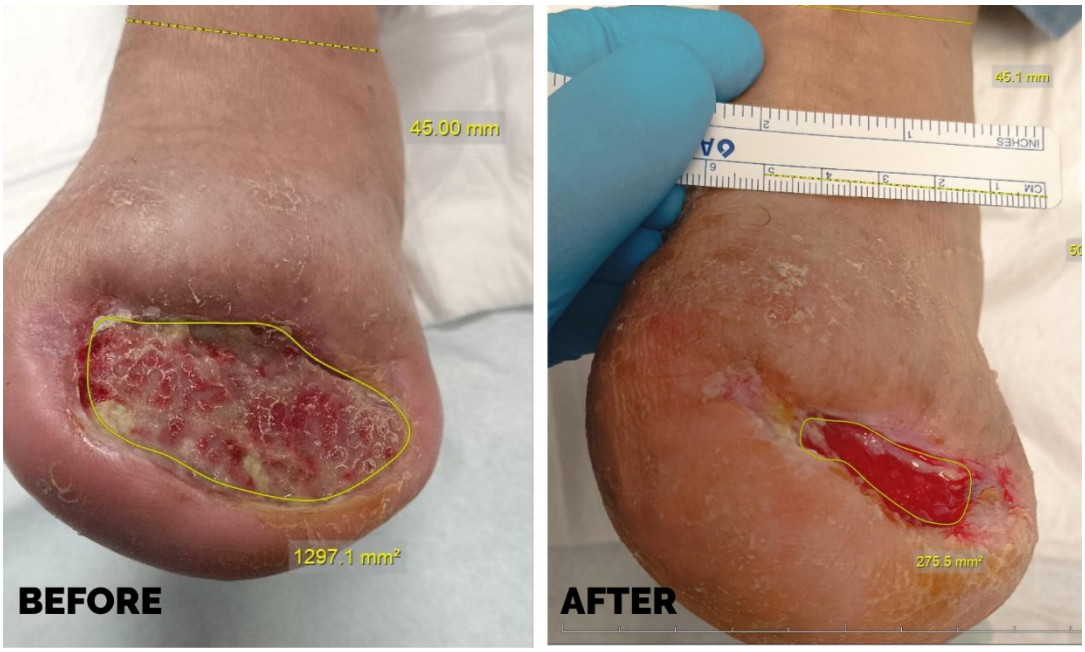

Figure 2. The wound's appearance before treatment and one month after treatment's initiation.

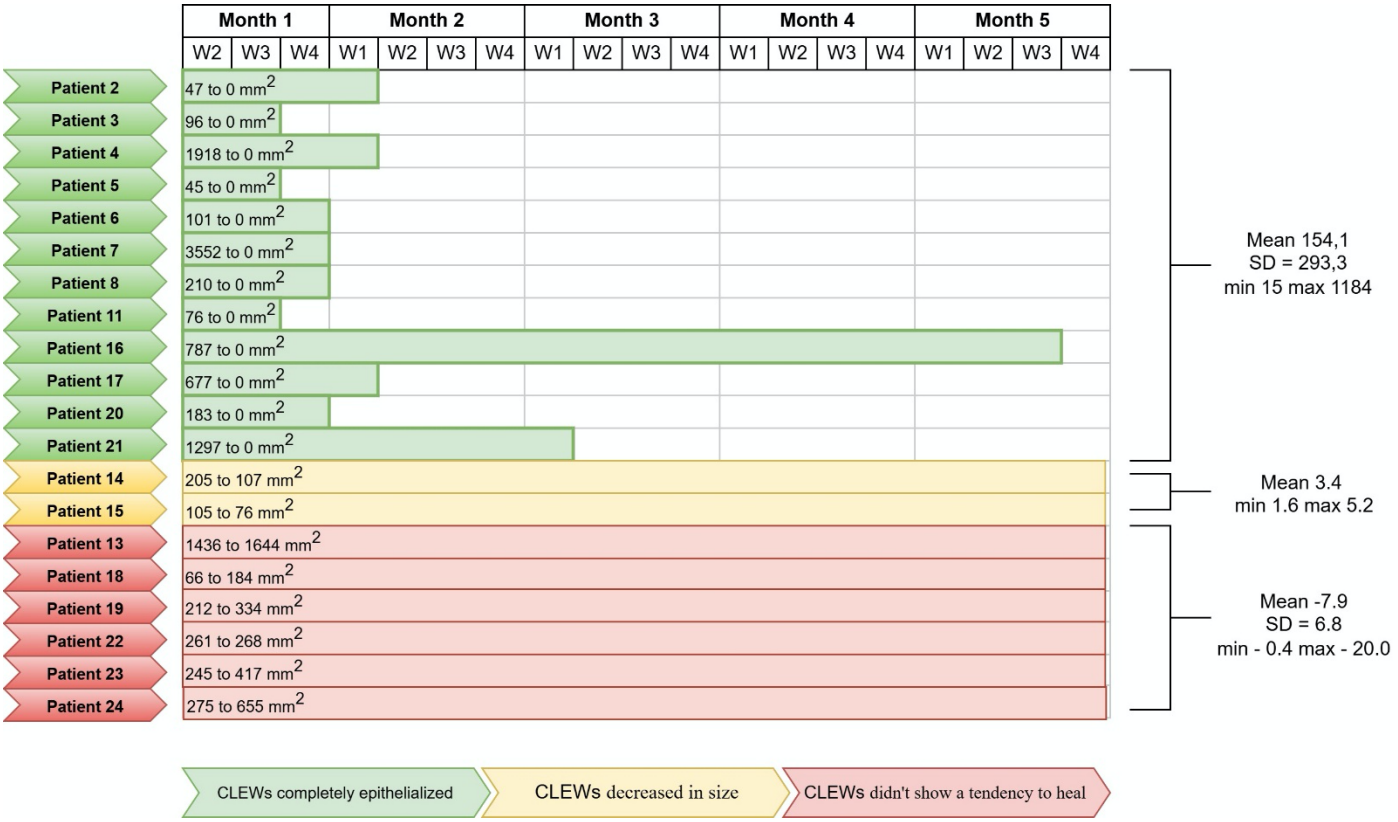

Figure 3. Characteristics of the wounds studied.

Risk factor (n)	The wounds have healed	The wounds haven't healed	
age > 70 yr (7)	4	3	Chi-Square = 0.848 p = 0.358
age < 70 yr (13)	10	3	
DM (6)	3	3	Chi-Square = 1.633 p = 0.202
no DM (14)	11	3	
OB (12)	8	4	Chi-Square = 1.371 p = 0.242
no OB (8)	6	2	
SD (12)	9	3	Chi-Square = 0.357 p = 0.551
no SD (8)	5	3	

Figure 4. The significance of differences in wounds healing depending on the impact of risk factors.