

THE EFFECT OF CO₂ LASER INTERVENTION ON RECURRENCE PREVENTION AFTER KELOID ULCER HEALING

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Running Title

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BACKGROUND

Keloid ulcer is a refractory clinical entity characterized by abnormal fibroproliferation, persistent ulceration, and high recurrence rates, which severely impacts patients' quality of life. Clinically, it often presents with symptoms such as localized pain, pruritus, and repeated exudation, and conventional treatments (e.g., surgical debridement, intralesional corticosteroid injection, or topical medication) face limitations: they can promote short-term ulcer healing but fail to effectively inhibit keloid hyperplasia, leading to recurrence rates as high as 60%–80% within 1 year after initial healing. Given the lack of standardized strategies for preventing keloid ulcer recurrence, exploring minimally invasive and effective intervention methods (such as laser therapy) has become a key focus in dermatological and plastic surgery research. CO₂ laser, as a widely used ablative laser, has shown potential in regulating fibroblast activity and reducing abnormal collagen deposition in keloid treatment; however, its efficacy and safety in preventing recurrence after keloid ulcer healing remain underreported.

METHODS

STUDY POPULATION

A total of 10 patients (6 females, 4 males; age range: 22–55 years, mean age: 38.6 ± 8.2 years) with post-keloid ulceration were enrolled in this single-center observational study from January 2024 to December 2024. All patients met the following criteria: (1) keloid ulcers located on the chest or abdomen (the most common sites for keloid formation due to high skin tension); (2) ulcer duration of 2–6 months, with no response to 4 weeks of conventional topical care (e.g., silver sulfadiazine ointment); (3) complete ulcer epithelialization confirmed by clinical examination at 1 month after initial wound care (defined as full coverage of the ulcer bed with intact epidermis, no exudation, and pain relief); (4) no history of CO₂ laser treatment or systemic immunosuppressive therapy within 6 months; and (5) willingness to complete 12 months of follow-up.

INTERVENTION PROTOCOL

All patients received fractional CO₂ laser treatment (device model: Lumenis Ultrapulse Encore, USA) starting at 1 month after ulcer healing. The laser parameters were standardized as follows: energy density of 70–100 J/cm², microspot size of 100

μm, ablation depth of 300–500 μm (adjusted based on keloid thickness, with deeper settings for lesions >5 mm thick), and a 20% overlap between adjacent treatment areas. Treatments were administered once every 2 months for a total of 5 sessions (total intervention duration: 8 months). Post-treatment care included topical application of recombinant human epidermal growth factor gel (twice daily for 1 week) to promote skin repair, and strict sun protection (SPF ≥30) to avoid post-inflammatory pigmentation.

OUTCOME MEASURES

All patients were followed up monthly for 12 months after the first laser session. The primary outcome was the 12-month recurrence rate (defined as the reappearance of ulceration, exudation, or progressive keloid hyperplasia at the original site). Secondary outcomes included: (1) changes in keloid thickness (measured by a digital caliper at baseline, after the 5th laser session, and at 12-month follow-up); (2) pruritus/pain severity (assessed using a 10-point Visual Analog Scale [VAS], where 0 = no symptoms and 10 = worst possible symptoms); and (3) treatment-related adverse events (e.g., transient erythema, pigmentation, or infection).

RESULTS

PRIMARY OUTCOME: RECURRENCE PREVENTION

After 12 months of follow-up, 5 out of 10 patients (50%) remained recurrence-free, with no signs of ulceration or keloid progression. The 5 patients who experienced recurrence showed symptom onset at 3–8 months after the last laser session (median recurrence time: 5.2 ± 1.8 months), and the recurrent lesions were smaller in size (mean maximum diameter: 1.2 ± 0.4 cm) compared to baseline (2.5 ± 0.6 cm).

SECONDARY OUTCOMES: KELOID REGRESSION AND SYMPTOM IMPROVEMENT

Keloid thickness: The mean thickness of keloids decreased significantly from 4.8 ± 1.2 mm at baseline to 2.1 ± 0.7 mm after the 5th laser session ($P < 0.01$), and remained stable at 2.3 ± 0.8 mm at 12-month follow-up (no significant increase compared to post-treatment levels, $P > 0.05$).

Symptom relief: The mean VAS scores for pruritus and pain decreased from 7.2 ± 1.5 and 6.8 ± 1.3 at baseline to 1.5 ± 0.8 and 1.2 ± 0.6 at 12 months, respectively (both $P < 0.01$).

CONCLUSION

Fractional CO₂ laser intervention (administered once every 2 months for 5 sessions, starting 1 month after keloid ulcer healing) exhibits significant efficacy in reducing keloid volume, relieving associated symptoms (pruritus and pain), and halting recurrence in 50% of patients over a 12-month period. However, the treatment cannot completely eliminate the risk of recurrence, as half of the patients still developed mild recurrent lesions. These findings suggest that CO₂ laser may serve as a promising adjuvant therapy for preventing keloid ulcer recurrence, but its clinical application should be combined with long-term follow-up. Future studies with larger sample sizes, randomized controlled designs, and exploration of combined therapies (e.g., laser + intralesional drug injection) are needed to further optimize recurrence prevention strategies for this refractory condition.