

# The Efficacy of Carbone Dioxide Laser Debridement Along With Low-Level Laser Therapy in Treatment of a Grade 3 Necrotic Burn Ulcer in a Paraplegic Patient (A Case Report)



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## Abstract

**Introduction:** A deep burn ulcer, especially in areas with sensory-motor dysfunction, is hard to cure.

**Case Report:** The patient was a 20-year-old paraplegic girl with a grade 3 necrotic burn ulcer for 3 weeks. We used a fractional Co<sub>2</sub> laser along with chemical debridement with trichloroacetic acid (TCA 80%) and low-level laser therapy (LLLT) with a 808 nm infrared laser, 6 J/cm<sup>2</sup> for the necrotic area, and a 650 nm red laser, 2 J/cm<sup>2</sup> for the open wound area. Complete healing occurred after 25 sessions without surgery.

**Conclusion:** Laser debridement along with LLLT and TCA administration may be useful to treat necrotic ulcers without surgery.

**Keywords:** Co<sub>2</sub> Laser debridement; Trichloroacetic Acid; Low-level laser Therapy; Wound healing.

## Introduction

Damaged necrotic skin in third-degree burns is highly susceptible to infection and must be removed by debridement. Debridement can be done surgically, chemically or by lasers. The carbon dioxide laser (Co<sub>2</sub>) has great potentials for surgical purposes. It can incise almost all tissues. Resulting heat automatically coagulates small vessels and induces hemostasis.<sup>1</sup> Early animal studies showed that the Co<sub>2</sub> laser could vaporize skin, crusts, dried blood, and pus in grade 3 burns without difficulty and with complete wound healing.<sup>2,3</sup> The material can be removed layer by layer until it can reach normal tissue. The Co<sub>2</sub> laser is a safe instrument in proper hands.<sup>4</sup>

The standard treatment after debridement for deep necrotic burns is the autologous split-thickness skin graft or rotation flap closure.<sup>2</sup> Autografts are highly successful immediately after laser debridement.<sup>1,5</sup>

Trichloroacetic acid (TCA) is used as a chemical peeling agent in dermatology. It penetrates the mid dermis and destroys the epidermal lesions. Acute post-inflammatory reaction stimulates cellular regeneration.<sup>6</sup> This agent has been used for non-surgical debridement and accelerating

the healing process in necrotic diabetic ulcers.<sup>7</sup>

In paralyzed patients, because of neurological and vascularization impairment, the healing process is complicated and using therapeutic methods like low-level laser therapy (LLLT) can accelerate the healing process. LLLT is an effective, safe, and non-invasive method for the treatment of complicated ulcers, including bedsores<sup>8,9</sup> and diabetic and venous ulcers.<sup>10-12</sup> These lasers have no thermal effects and stimulate the healing process by improving microcirculation, fibroblast proliferation, collagen synthesis, granulation tissue formation, regenerative capacity, and cellular metabolic processes of injured tissues and by modulating the immune system.<sup>13,14</sup>

In this case report, for the first time, we used the Co<sub>2</sub> laser, TCA and LLLT for healing the ulcer without the skin graft in a paralyzed patient.

## Case Report

The patient was a 20-year-old paraplegic girl due to meningomyelocele since her childhood. She had had a grade 3 burn ulcer due to hot water bag usage on the sacral area for 3 weeks ago. She was dressed in mupirocin

and mafenide ointments and the necrotic surface was scratched with a scalpel during this period in Motahari burn center, but as there was no improvement, she was a candidate for surgical debridement and a skin graft by a plastic surgeon. She did not accept surgery and was referred to a laser clinic. Photography was done and calculated with Pictzar software which was 52 cm<sup>2</sup>. Three protocols were used to treat this ulcer: 1- CO<sub>2</sub> laser debridement, 2- Chemical debridement with TCA, and 3- LLLT.

**Protocol 1- CO<sub>2</sub> laser debridement:** We used the Unixel CO<sub>2</sub> laser (Union medical Co., South Korea), 10.60 nm. As removing all the necrotic skin in one session would induce an open ulcer which needed a skin graft and patient did not agree with the surgical procedure, we used a fractional mode, 6 W (Level=20), point of shot: 4, pulse width: 1250 μs, with medium micro thermal zone (MTZ), pitch: 0.8, which produces 169 micro-cavities (300 micron is the diameter of each micro-cavity) in 20 × 20 mm spot size for debridement.

**Protocol 2- Chemical debridement:** After CO<sub>2</sub> laser debridement, TCA 80% was applied over the necrotic area by a cotton applicator. Laser-induced micro-cavities would increase TCA penetration.

**Protocol 3- LLLT:** We used an 808 nm, 200 mW laser with 1 cm<sup>2</sup> radiation area, 6 J/cm<sup>2</sup>, contact, continuous mode (a portable 3L laser, Iran), over the necrotic area and the surrounding healthy skin.

After each session dressing was done by using mupirocin ointment, mafenide ointments, and sterile wet gauze.

Protocol 2 and 3 were applied every other day for 25 sessions. The necrotic layer gradually began to separate from the sidelines. To irradiate these fresh ulcers, the portable laser probe (PLP), 650 nm, 150 mW, radiation area: 0.25 cm<sup>2</sup>, power density: 0.6 W/cm<sup>2</sup>, contact, continuous mode, 2 J/cm<sup>2</sup>, (Canadian Optic Laser Center,

COL laser, Canada) was used. This is a suggested protocol for wound treatment in most studies.<sup>10,15,16</sup>

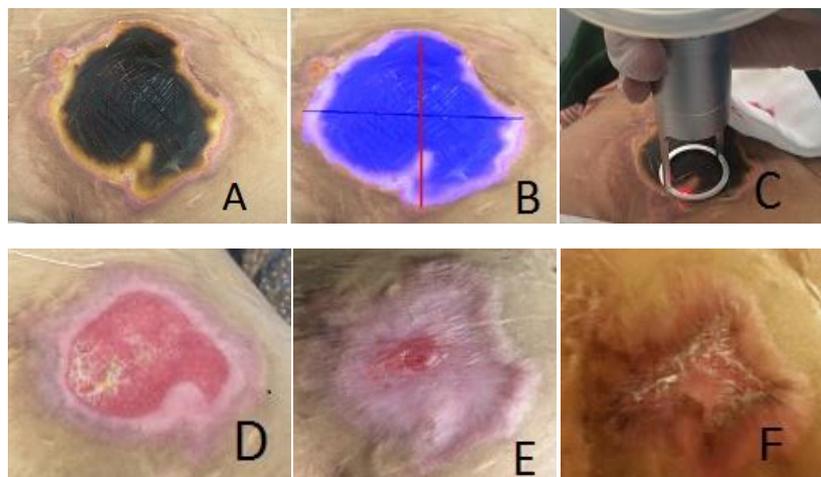
After 10 sessions of TCA and laser therapy, the necrotic layer was separated (Figure 1D) and after 25 sessions (2 months), complete healing occurred. The Patient had no side effects or discomfort during this period and one-year follow-up.

## Discussion

In this study, for the first time we used CO<sub>2</sub> laser debridement along with chemical debridement with TCA and LLLT for treatment of a deep necrotic ulcer without surgery. The CO<sub>2</sub> laser created tiny holes on the necrotic surface for TCA to penetrate deeper and the combination of these two helped to remove the thick necrotic tissue without surgery as patient wished and LLLT induced wound healing by increasing perfusion, stimulation of fibroblasts, and epithelial cells.<sup>11,12,17</sup>

Our results showed this method might be useful therapeutically, even in complicated situations, including paraplegic patients without any side effects. Although surgical debridement followed by an autologous skin graft is the gold standard treatment in deep necrotic ulcers, this method has several complications, including the need to hospitalization, the risk of anaesthesia, and surgery. In this study, instead of surgical debridement of a large area which needed a skin graft, we gradually removed the layer by a fractional laser and chemical debridement and used LLLT for healing the ulcer. The patient's ulcer healed completely during 2 months.

Our previous finding showed that LLLT has significant effects on growth factors involved in wound healing, including EGF, FGF, and PDGF,<sup>17</sup> on wound healing, neuropathy, and metabonomics of diabetic patients.<sup>10,18,19</sup> Moreover, its positive effects have been observed in treatment of pressure ulcer,<sup>8</sup> after skin graft surgery,<sup>20,21</sup>



**Figure 1.** A: the Grade 3 burn ulcer for 3 weeks, B: surface measurement by software, C: CO<sub>2</sub> laser debridement, D: After 10 sessions of a low-level laser and TCA therapy, the necrotic layer was separated completely. E: After 25 sessions of a low-level laser and TCA therapy, F: 1 month after complete healing.

and post-cesarean surgery.<sup>22</sup> Several reviews and meta-analyses introduce LLLT as an effective therapeutic modality for wound healing.<sup>11,12</sup> Lucas et al evaluated the effect of LLLT for treatment of a stage 3 decubitus ulcer in a randomized clinical trial.<sup>9</sup> Several reviews and clinical trials indicate the efficacy of LLLT for wound healing,<sup>12,23</sup> but these studies are mainly focused on diabetic, venous and pressure ulcers and we did not find any clinical trials which evaluate the effect of LLLT in burned patients except our previous study in which we used LLLT for treating a grade 3 burn ulcer in diabetic patients who were a candidate for amputation.<sup>20</sup>

Levin et al compared laser debridement and surgical debridement in pigs with 10%-15% body surface area burns. Their results showed that blood loss was significantly reduced in the laser group and the applied autografts to the lased area took better than the surgery group. Then they used this technique on a patient with a symmetrical third-degree burn ulcer. Again, they reported blood loss reduction in the laser debrided side compared with the scalpel excised side, but the healing of the skin graft in both sides was comparable.<sup>1</sup> Domankevitz et al used the CO<sub>2</sub> laser for debridement of burn ulcers before skin grafting. They reported that this method is useful for cutaneous surgery and debridement of burn wounds before skin grafting.<sup>3</sup> Stellar et al used laser debridement for a decubitus ulcer.<sup>5</sup>

Nilforoushzade et al used TCA along with autologous fibroblast suspension to treat a diabetic foot ulcer<sup>7</sup> and the scar of leishmaniasis.<sup>24</sup> Cho et al reported that a high concentration of TCA (65%-100%) can stimulate dermal fibroblasts and increase the collagen content.<sup>25</sup>

## Conclusion

Laser debridement along with LLLT and TCA administration may be useful to treat necrotic ulcers without surgery.

## Ethical Considerations

An informed consent was obtained from the patient for publication of this report.

## Conflict of Interests

The authors declare no conflict of interest.

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