UC Irvine

UC Irvine Previously Published Works

Title

Ablative Fractional Resurfacing for Chronic Wounds from Traumatic Scarring: A Case Report and Literature Review.

Permalink

<https://escholarship.org/uc/item/8cp5h6kf>

Journal

Journal of drugs in dermatology : JDD, 19(11)

ISSN

1545-9616

Authors

Mehrabi, Joseph N
Kelly, Kristen M

Publication Date

2020-11-01

DOI

10.36849/jdd.2020.5444

Copyright Information

This work is made available under the terms of a Creative Commons Attribution License, available at <https://creativecommons.org/licenses/by/4.0/>

Peer reviewed

Ablative Fractional Resurfacing for Chronic Wounds from Traumatic Scarring: A Case Report and Literature Review

Joseph N. Mehrabi,^a Kristen M. Kelly MD^{a,b}

^aUniversity of California, Irvine, CA

^bBeckman Laser Institute, Laser Microbeam and Medical Program, University of California Irvine, Irvine, CA

ABSTRACT

Ablative fractional resurfacing (AFR) can be utilized to improve scar appearance, texture, pain and associated contractures. Non-healing ulcers can also develop in areas of scarring and, in some cases, AFR can be utilized to heal these chronic wounds. We present a case of scarring with non-healing ulceration refractory to wound care, debridement and hydrotherapy successfully healed in four sessions with AFR using a 2940 nm Er:YAG laser. We review the literature on AFR for wound healing including potential mechanisms. AFR can be considered for non-healing ulcers in areas of scarring, once malignancy and infection are ruled out, and has the potential to provide relief for these suffering patients.

J Drugs Dermatol. 2020;19(11):1112-1115. doi:10.36849/JDD.2020.5444

INTRODUCTION

The efficacy of lasers for scar treatment is well documented and multiple lasers are known to improve scars. Ablative fractional resurfacing (AFR) can be especially beneficial to improve scar appearance, texture, pain and associated contractures.¹ AFR is performed with carbon dioxide (CO₂) and erbium yttrium aluminum garnet (Er:YAG) lasers with water as the target chromophore.

Fractional photothermolysis works by creating columns or microthermal treatment zones (MTZs) of controlled thermal injury with a grid-like pattern at an operator-determined depth and density.² The clinician can target the approximate depth of the scar and make depth and density adjustments based on body location as well as scar characteristics. The healthy skin between the MTZs facilitates a rapid wound healing response contributing collagen reconstruction and scar remodeling.³ The ablated pinholes from AFR also relax skin contractures, promoting improvement, some immediate, in areas of tension.^{4,5} The open MTZs also can act as channels for topical drug delivery, which can be used to enhance treatment and achieve less painful more uniform distribution of drugs.⁶

AFR has been established as the first line method for the treatment for traumatic scars in many centers.^{7,8} Multiple studies have consistently documented significant subjective and objective improvements in scar appearance, color, height, texture, pliability, restriction, pain and itch, as well as an overall improvement in quality of life.⁸ Most experts agree that AFR is the most effective overall laser platform for traumatic scars.⁸

Non-healing ulcers can develop in areas of scarring. Previous reports have demonstrated success treating select chronic

ulcers in the presence of scar contractures with AFR, citing decreased tension from improved scar pliability and texture, along with potential wound debridement, biofilm disruption, and molecular changes in the skin.^{1,9-13} We present a case of traumatic scarring with non-healing ulceration treated with AFR to facilitate wound healing and then review the literature on this indication for AFR.

CASE REPORT

A 69-year-old obese and hypertensive female presented with a two-year history of multiple chronic, non-healing ulcers on the central abdomen with surrounding scarring refractory to standard wound care. Four years prior, a dermatitis of unspecified etiology developed, and ulceration occurred. The cause of the ulceration was unclear but pruritus and aggressive scratching were thought to have contributed per chart review. Months later, she underwent an Oasis[®] grafting procedure. The graft became pruritic and the wounds returned, grew in size, and became increasingly painful. Biopsies were performed to rule out malignancy, fungal infection, and vasculitis. The wounds were repeatedly infected and did not respond to wound care, debridement, or hydrotherapy.

After multiple cycles of wound-improvement and recurrence, the wound-care specialist referred the patient for AFR in an effort to assist with wound healing. On physical exam, multiple open erosions on the central abdomen ranging from 1 to 3 cm in size were present with surrounding contracted scar tissue measuring about 8 cm x 5 cm. After evaluation, we proceeded with AFR using a 2940 nm Er:YAG laser (Sciton, Profractional, Palo Alto, CA). Prior to each laser application, the treatment area was topically anesthetized for 1 hour, cleaned

FIGURE 1. The appearance of the patient's scar and non-healing ulcer (A) upon presentation, (B) three weeks after the first laser treatment, (C) immediately prior to the third treatment, and (D) immediately prior to the fourth and final AFR treatment. The patient did not return for follow-up after the fourth treatment.

with chlorhexidine followed by sterile water, then carefully dried. Appropriate eyewear and masks were worn, and a smoke evacuator was used. The patient was treated four times at 6 to 8-week intervals using a fractionated 2940 nm Er:YAG Profractional laser (Sciton, Palo Alto, CA) with settings of 5.5% density and fluence ranging from 162.5-187.5 J/cm². The ulcer and surrounding area of scar were treated. The open wounds healed completely over the course of treatment (Figure 1). No adverse effects or complications were observed.

DISCUSSION

Lasers are known to improve scars and are commonly used by dermatologic, plastic and burn surgeons to decrease scar associated morbidity.¹⁴ AFR was first introduced in 2007 and has subsequently become widely accepted as a first-line treatment for traumatic scarring.¹⁸ We report a case where AFR was used to mitigate scarring and heal a chronic ulcer refractory to other treatments. Complete healing of the chronic wounds was achieved.

Prior works (Table 1) have evaluated AFR for the healing of chronic wounds.^{1,9-12} Cases presented by Uebelhoefer et al and Shumaker et al included severe scarring, contractures, and chronic nonhealing wounds from burns¹ and an explosive device blast⁹ refractory to split-thickness skin grafting, physical therapy, and proper wound care. The scars on both patients were treated with CO₂ AFR using fluences ranging from 17.5 to 50 mJ and densities between 5 and 15%. The chronic wounds were treated with lower fluences and 3 to 5 weeks after a single AFR treatment, the ulcers in these patients were completely re-epithelialized. Another 3-patient case series by the same group included nonhealing wounds and severe scarring after explosive device injuries and reported complete reepithelization after AFR.

Additional case reports have been published on nonhealing wounds in elderly patients, resulting from trauma and Mohs micrographic surgery, that responded to AFR.¹¹ Laser parameters included 30 mJ of energy at 5% density applied to the base of the wounds and 50 mJ to the surrounding skin for only one treatment, and complete healing was observed after 3 to 6 weeks, including in one diabetic patient.¹¹ In another pilot

study, ultrapulsed CO₂ laser at 4J was administered weekly to nine patients with diabetic ulcers with exposed bone.¹⁵ After a maximum of six treatments, four patients completely healed, one developed granulation tissue, three did not heal, and one underwent minor amputation.¹⁵ In the same study with the same treatment parameters, AFR was combined with platelet-rich plasma for the treatment of diabetic foot ulcers with exposed bone in five elderly patients, two of which healed in three months, two more developed granulation tissue, and the final patient saw no improvement and underwent amputation.¹⁵

Reported cases of AFR application in chronic wounds of pediatric patients have also demonstrated benefit.¹² Krakowski et al used AFR on an 8-year-old healthy female with restrictive scarring and a nonhealing wound of eight months duration on her forearm from a chemical burn. Aggressive cryotherapy caused nonhealing wounds in a 17-year-old healthy male, which failed to heal after proper wound care, possibly due to recurrent trauma from football practice. The chronic wounds in both cases were treated twice using ablative fractional CO₂ at a fluence of 50 mJ and density of 5%, resulting in complete re-epithelialization and improvement in scar texture and pliability.¹²

The method of wound closure prompted by AFR warrants exploration. One theory is that AFR allows local relaxation of tissue and perhaps generation of additional collagen, relaxing tension in the scar area and allowing chronic wounds to close. By improving the pliability of the surrounding skin, oxygen circulation to the wound may also be increased, fostering more rapid healing.¹¹ Other theories suggest AFR of chronic wounds exerts mechanical effects, stimulates collagen remodeling and triggers angiogenesis to activate a more effective wound healing process.¹⁶

AFR has shown efficacy in the treatment of acute induced wounds in diabetic mice, more effectively reducing the size of the original wound when compared to natural healing.¹⁷ In this study, treatment groups exhibited significantly increased vascular endothelial growth factor (VEGF) and basic fibroblast growth factor (bFGF) mRNA expression with reductions in the expression of transformation growth factor-β (TGF-β) mRNA.¹⁷

TABLE 1.

Summary of Prior Cases								
Publication	Age	Sex	Injury	Location	Laser	Settings	No. of Tx	Outcomes
Uebelhoer et al 2012 ¹	52	M	Burn scar with contracture and non-healing ulcer	R elbow	PDL	4 J/cm ² fluence, 1.5 ms pulse duration, 10 mm spot size	1	2 weeks post: additional 12 degrees extension.
					AF CO ₂	40 mJ fluence (20 mJ at wound base), 5% density		5 weeks post: increased extension and full re-epithelialization of the ulcer.
SHUMAKER et al 2012 ⁹	22	M	Explosive device blast with poor skin mobility with skin fragility and chronic ulcers	L leg amputation stump	AF CO ₂	17.5-50 mJ fluence, 5% to 15% density with higher fluences necessitating decreased density	2	3 weeks post initial treatment: significant interval improvement in wound healing skin pliability, and durability allowing prosthetic use. 3 months post final treatment: Progressive improvement and undergoing rehabilitation and walking.
	26	M	Explosive device blast with poor skin mobility with skin fragility and chronic ulcers	R leg amputation stump	AF CO ₂	50 mJ, 5% density, 250 μ s pulse duration, 120 μ m spot size	2	8 months post final treatment: improvements in texture, pigmentation, and skin pliability. Complete resolution of ulcers.
Shumaker et al 2012 ¹⁰	28	M	Explosive device blast with hyper-trophic graft site and persistent erosion	R amputation stump	AF CO ₂	30 mJ, 5% density, 250 μ s pulse duration, 120 μ m spot size	2	Complete re-epithelialization of erosion 6 days post treatment. Improved skin texture and pliability.
	39	M	Explosive device blast with persistent ulcer and scar contracture	R elbow	AF CO ₂	50 and 30 mJ, 5% density, 250 μ s pulse duration, 120 μ m spot size	3	Sustained healing of the ulcer during follow-up. Improved skin pliability and range of motion.
Phillips et al 2015 ¹¹	70	F	Degloving injury with non-healing wound	Dorsum of foot	AF CO ₂	50 mJ fluence (30 mJ at wound base), 5% density	1	Wound was completely healed 6 weeks after treatment.
	70	M	Non-healing Mohs surgical wound	R shin	AF CO ₂	50 mJ fluence (30 mJ at wound base), 5% density	1	Wound was completely healed 3 weeks after treatment.
Krakowski et al 2016 ¹²	8	F	Scalding chemical burn injury with non-healing wound from repetitive friction	L forearm with contractures	AF CO ₂	50 mJ fluence, 5% density	2	2 months post initial treatment: near-complete healing. 2 months post final treatment: complete re-epithelialization with improved skin pliability and texture.
	17	M	Aggressive cryotherapy of verruca vulgaris; non-healing wounds resulting from repeated football practice	L shin	AF CO ₂	50 mJ fluence, 5% density	2	1 month post initial treatment: near complete granulation. 1 month post final treatment: complete healing. 4 months post final treatment: complete healing with residual post-inflammatory dyspigmentation.
This report	69	F	Rash subject constant scratching	Abdomen	AF Er:YAG	162.5-187.5 J/cm ² , 5% density	4	The open wound gradually healed over the course of treatment. No adverse effects were observed.

AF: Ablative Fractional; PDL: Pulsed dye laser; Er:YAG: Erbium yttrium aluminum garnet laser; CO₂: Carbon dioxide laser

Discussions of histological and biochemical changes involved in AFR have focused on the upregulation of TGF- β , heat shock proteins (HSP), and matrix metalloproteinases (MMP).¹⁸ TGF- β signaling is often documented as suppressed in chronic wounds but its role in wound healing is still unclear.¹⁸⁻²¹ HSPs have been established as regulators of the wound healing response by promoting or suppressing TGF- β expression and fibrosis.^{18,22-30} Additionally, different MMPs are stimulated throughout different phases of the wound healing process after AFR, regulating collagen synthesis and degradation.^{18,31}

It is important to note that not every non healing ulcer in an area of scarring would be a good candidate for laser treatment. Malignancy and infection need to be ruled out with appropriate techniques, including biopsy and culture. The potential contribution of vascular compromise must also be considered. However, once other contributing factors are explored, then AFR may be considered.

AFR has revolutionized scar treatment and, as demonstrated by this case and review, can benefit select patients with chronic wounds in the setting of scarring. AFR should be considered for non-healing ulcers in areas of scarring, as it can provide the potential for relief for these suffering patients.

CONCLUSION

AFR can be considered for non-healing ulcers in areas of scarring, once malignancy and infection are ruled out. There are multiple theories regarding the mechanism of action, but further investigation is warranted.

DISCLOSURES

The second author is a consultant for Sciton Inc., who provided the device used in this case report.

REFERENCES

1. Uebelhoe NS, Ross EV, Shumaker PR. Ablative fractional resurfacing for the treatment of traumatic scars and contractures. *Semin Cutan Med Surg*. 2012;31(2):110-120.
2. Manstein D, Herron GS, Sink RK, Tanner H, Anderson RR. Fractional photothermolysis: a new concept for cutaneous remodeling using microscopic patterns of thermal injury. *Lasers Surg Med*. 2004;34(5):426-438.
3. Ozog DM, Liu A, Chaffins ML, et al. Evaluation of clinical results, histological architecture, and collagen expression following treatment of mature burn scars with a fractional carbon dioxide laser. *JAMA dermatology*. 2013;149(1):50-57.
4. Cho SB, Lee SJ, Kang JM, Kim YK, Kim DH. Treatment of scars with flexion contracture using carbon dioxide laser and fractional photothermolysis. *J Dermatolog Treat*. 2010;21(4):218-220.
5. Cox JA, Dainer M, Shumaker PR. Ablative fractional laser resurfacing for abdominal scar contractures in pregnancy. *Obstet Gynecol*. 2015;125(4):924-926.
6. Cavalié M, Sillard L, Montaudie H, Bahadoran P, Lacour JP, Passeron T. Treatment of keloids with laser-assisted topical steroid delivery: a retrospective study of 23 cases. *Dermatol Ther*. 2015;28(2):74-78.
7. Hantash BM, Bedi VP, Chan KF, Zachary CB. Ex vivo histological characterization of a novel ablative fractional resurfacing device. *Lasers Surg Med*. 2007;39(2):87-95.
8. Seago M, Shumaker PR, Spring LK, et al. Laser treatment of traumatic scars and contractures: 2020 international consensus recommendations. *Lasers Surg Med*. 2020;52(2):96-116.
9. Shumaker PR, Kwan JM, Landers JT, Uebelhoe NS. Functional improvements in traumatic scars and scar contractures using an ablative fractional laser protocol. *J Trauma Acute Care Surg*. 2012;73(2 Suppl 1):S116-121.
10. Shumaker PR, Kwan JM, Badiavas EV, Waibel J, Davis S, Uebelhoe NS. Rapid healing of scar-associated chronic wounds after ablative fractional resurfacing. *Arch Dermatol*. 2012;148(11):1289-1293.
11. Phillips TJ, Morton LM, Uebelhoe NS, Dover JS. Ablative fractional carbon dioxide laser in the treatment of chronic, posttraumatic, lower-extremity ulcers in elderly patients. *JAMA Dermatol*. 2015;151(8):868-871.
12. Krakowski AC, Diaz L, Admani S, Uebelhoe NS, Shumaker PR. Healing of chronic wounds with adjunctive ablative fractional laser resurfacing in two pediatric patients. *Lasers Surg Med*. 2016;48(2):166-169.
13. Morton LM, Dover JS, Phillips TJ, Krakowski AC, Uebelhoe NS. Treatment of ulcers with ablative fractional lasers. *Semin Cutan Med Surg*. 2015;34(1):37-41.
14. Anderson R, Donelan MB, Hivnor C, et al. Laser treatment of traumatic scars with an emphasis on ablative fractional laser resurfacing: Consensus report. *JAMA Dermatology*. 2014;150(2):187-193.
15. Monami M, Mirabella C, Scatena A, et al. CO(2) laser for the treatment of diabetic foot ulcers with exposed bone. A consecutive series of type 2 diabetic patients. *J Endocrinol Invest*. 2017;40(8):819-822.
16. Mervis JS, Phillips TJ. The Role of Ablative Fractional Lasers in Wound Healing. In: *Local Wound Care for Dermatologists*. Springer; 2020:121-128.
17. Lee HN, Bae JM, Goo BCL, Park YM. Promotion of wound healing through low-fluence ablative fractional laser treatment in diabetic mice. *Lasers Med Sci*. 2019;34(2):421-425.
18. Leaker BD, Fuchs C, Tam J. When wounds are good for you: the regenerative capacity of fractional resurfacing and potential utility in chronic wound prevention. *Adv Wound Care (New Rochelle)*. 2019;8(12):679-691.
19. Badr G. Camel whey protein enhances diabetic wound healing in a streptozotocin-induced diabetic mouse model: the critical role of β -Defensin-1, -2 and -3. *Lipids in Health and Disease*. 2013;12(1):46.
20. Ramirez H, Patel SB, Pastar I. The role of TGF β signaling in wound epithelialization. *Adv Wound Care (New Rochelle)*. 2014;3(7):482-491.
21. Enoch S, Grey JE, Harding KG. Recent advances and emerging treatments. *BMJ*. 2006;332(7547):962-965.
22. Sakai G, Tokuda H, Fujita K, et al. Heat shock protein 70 negatively regulates TGF β -stimulated VEGF synthesis via p38 MAP kinase in osteoblasts. *Cell Physiol Biochem*. 2017;44(3):1133-1145.
23. Shang Y, Xu X, Duan X, et al. Hsp70 and Hsp90 oppositely regulate TGF β signaling through CHIP/Stub1. *Biochem Biophys Res Commun*. 2014;446(1):387-392.
24. Bellaye PS, Burgoyne O, Causse S, Garrido C, Bonniaud P. Heat shock proteins in fibrosis and wound healing: good or evil? *Pharmacol Ther*. 2014;143(2):119-132.
25. Yun CH, Yoon SY, Nguyen TT, et al. Geldanamycin inhibits TGF β signaling through induction of Hsp70. *Arch Biochem Biophys*. 2010;495(1):8-13.
26. Wrighton KH, Lin X, Feng XH. Critical regulation of TGF β signaling by Hsp90. *Proc Natl Acad Sci U S A*. 2008;105(27):9244-9249.
27. Abu-Elsaad NM, Serrya MS, El-Karef AM, Ibrahim TM. The heat shock protein 90 inhibitor, 17-AAG, attenuates thioacetamide induced liver fibrosis in mice. *Pharmacol Rep*. 2016;68(2):275-282.
28. He W, Zhuang Y, Wang L, et al. Geranylgeranylacetone attenuates hepatic fibrosis by increasing the expression of heat shock protein 70. *Mol Med Rep*. 2015;12(4):4895-4900.
29. Noh H, Kim HJ, Yu MR, et al. Heat shock protein 90 inhibitor attenuates renal fibrosis through degradation of transforming growth factor- β type II receptor. *Lab Invest*. 2012;92(11):1583-1596.
30. Tanaka K, Tanaka Y, Namba T, Azuma A, Mizushima T. Heat shock protein 70 protects against bleomycin-induced pulmonary fibrosis in mice. *Biochem Pharmacol*. 2010;80(6):920-931.
31. Reilly MJ, Cohen M, Hokugo A, Keller GS. Molecular effects of fractional carbon dioxide laser resurfacing on photodamaged human skin. *Arch Facial Plast Surg*. 2010;12(5):321-325.

AUTHOR CORRESPONDENCE

Kristen M. Kelly MD

E-mail: kmkelly@hs.uci.edu