

This article was downloaded by:[CDL Journals Account]
On: 28 September 2007
Access Details: [subscription number 780222585]
Publisher: Informa Healthcare
Informa Ltd Registered in England and Wales Registered Number: 1072954
Registered office: Mortimer House, 37-41 Mortimer Street, London W1T 3JH, UK



Journal of Cosmetic and Laser Therapy

formerly Journal of Cutaneous Laser Therapy

Publication details, including instructions for authors and subscription information:
<http://www.informaworld.com/smpp/title~content=t713399564>

Fractional photothermolysis for the treatment of surgical scars: A case report

Daniel S. Behroozan^{ab}; Leonard H. Goldberg^{ac}; Tianhong Dai^d; Roy G. Geronemus^e; Paul M. Friedman^{af}

^a DermSurgery Associates, Houston, TX, USA

^b Division of Dermatology, David Geffen School of Medicine at UCLA, CA, USA

^c Department of Medicine (Dermatology), University of Texas, MD Anderson Cancer Center, Houston, TX, USA

^d Department of Bioengineering, Rice University, Houston, TX, USA

^e Laser & Skin Surgery Center of New York, NY, USA

^f Department of Dermatology, University of Texas Medical School, Houston, TX, USA

Online Publication Date: 01 April 2006

To cite this Article: Behroozan, Daniel S., Goldberg, Leonard H., Dai, Tianhong, Geronemus, Roy G. and Friedman, Paul M. (2006) 'Fractional photothermolysis for the treatment of surgical scars: A case report', Journal of Cosmetic and Laser Therapy, 8:1, 35 - 38

To link to this article: DOI: 10.1080/14764170600607251

URL: <http://dx.doi.org/10.1080/14764170600607251>

PLEASE SCROLL DOWN FOR ARTICLE

Full terms and conditions of use: <http://www.informaworld.com/terms-and-conditions-of-access.pdf>

This article maybe used for research, teaching and private study purposes. Any substantial or systematic reproduction, re-distribution, re-selling, loan or sub-licensing, systematic supply or distribution in any form to anyone is expressly forbidden.

The publisher does not give any warranty express or implied or make any representation that the contents will be complete or accurate or up to date. The accuracy of any instructions, formulae and drug doses should be independently verified with primary sources. The publisher shall not be liable for any loss, actions, claims, proceedings, demand or costs or damages whatsoever or howsoever caused arising directly or indirectly in connection with or arising out of the use of this material.

CASE REPORT

Fractional photothermolysis for the treatment of surgical scars: A case report

DANIEL S. BEHROOZAN^{1,2}, LEONARD H. GOLDBERG^{1,3}, TIANHONG DAI⁴,
ROY G. GERONEMUS⁵ & PAUL M. FRIEDMAN^{1,6}

¹DermSurgery Associates, Houston, TX, USA, ²Division of Dermatology, David Geffen School of Medicine at UCLA, Los Angeles, CA, USA, ³Department of Medicine (Dermatology), University of Texas, MD Anderson Cancer Center, Houston, TX, USA, ⁴Department of Bioengineering, Rice University, Houston, TX, USA, ⁵Laser & Skin Surgery Center of New York, NY, USA, and ⁶Department of Dermatology, University of Texas Medical School, Houston, TX, USA

Abstract

Background. Surgical scars are a challenging condition to treat. Fractional photothermolysis provides a promising new modality for treatment.

Case report. A 55-year-old white female patient with a surgical scar on the chin was treated with fractional photothermolysis (1550 nm FraxelTM SR laser). A single treatment session was performed at pulse energy of 8 mJ (MTZ) and a final density of 2000 MTZ/cm². The treatment response was assessed by comparing pre- and 2-week post-treatment clinical photography.

Results. A greater than 75% clinical improvement of scarring was achieved at 2 weeks after a single treatment based on independent physician assessment. No significant adverse effects were noted. The improvement was persistent at 1-month follow-up.

Conclusion. Fractional photothermolysis offers a new, effective, and safe modality for the treatment of surgical scars.

Key words: Fractional photothermolysis, Fraxel, scar, laser, surgical

Background

Hypertrophic scars are a common complication among patients suffering from surgical procedures, traumatic wounds, or burn injuries. They are elevated, firm and erythematous because of the increase in microvasculature (1). Hypertrophic scars are primarily of cosmetic concern, especially on the face; however, some lesions can cause contractures, which may result in loss of function if overlying a joint. They can be both painful and pruritic, and approximately 1.5–4.5% of the general population is affected (2). The mechanism of hypertrophic scar formation is still not completely understood. Abundant collagen accumulation and fibroplasia may result from either excessive synthesis of collagen, fibrin, and proteoglycans or deficient matrix degradation and remodeling (3).

The treatment of hypertrophic scars is challenging because of the high recurrence rate and the incidence of side effects associated with treatment (4). The pulsed dye laser at the 585–595 nm

wavelength, which relies on the principle of selective photothermolysis (5), is the current standard for treatment of hypertrophic scars (2,6–22). However, clinical studies have shown that complete clearing of erythema and/or thickness of scars is not commonly achieved, and multiple treatment sessions are usually required to obtain optimum clearing (2,8,14,15,17–22). Moreover, in some cases, hypertrophic scars are poorly responsive to conventional pulsed dye laser irradiation (23).

In contrast to selective photothermolysis, which aims to produce bulk thermal injury in particular targets within skin, fractional photothermolysis creates hundreds to thousands of microthermal zones (MTZs) and spares the tissue surrounding each MTZ (24,25). We report the case of a white female patient with scarring of the chin secondary to surgical excision of a basal cell carcinoma who was treated with a single treatment of fractional photothermolysis resulting in a greater than 75% clinical improvement based on independent physician assessment of clinical photography.

Correspondence: Paul M. Friedman, DermSurgery Associates, 7515 S. Main Street, Suite 210, Houston, TX 77030, USA. Fax: 1 713 791 9927. E-mail: pmfriedman@dermsurgery.org

(Received 15 September 2005; accepted 30 November 2005)

Case report

A 55-year-old white female patient with Fitzpatrick type II skin (26) presented with scarring to the left side of the chin (Figure 1), which had resulted from Mohs' excision of a basal cell carcinoma 4 weeks prior to presentation. The patient denied a history of keloid formation or isotretinoin use within the last 6 months. The treatment area was thoroughly cleansed prior to the procedure using a mild, gently abrasive skin cleanser. OptiGuide Blue, a FDA certified water-soluble tint, was applied to the treatment area to highlight the contours of the skin. This allowed the laser's intelligent optical tracking system to detect contact with the skin and to adjust the treatment pattern with respect to handpiece velocity. For 1 hour prior to treatment, 30% topical lidocaine ointment was applied. A single treatment with the 1550 nm wavelength Fraxel (R) SR laser (Reliant Technologies Inc., Mountain View, CA, USA) at pulse energy of 8 mJ and a final density of 2000 MTZ/cm² was performed.

Postoperative erythema was noted, which resolved within 24 hours. Follow-up results at 2 weeks revealed a greater than 75% clinical improvement in the degree of erythema, induration, and overall texture based on independent physician clinical assessment using a quartile grading scale (0–25%: no improvement; 25–50%: mild improvement; 50–75%: moderate improvement; > 75%: dramatic improvement). The patient's degree of satisfaction paralleled the physician's assessment of improvement (Figure 2). A 1-month follow-up visit revealed persistence in clinical improvement.

Discussion

The flashlamp-pumped pulsed dye laser utilizes the principle of selective photothermolysis and has extensively been used for the treatment of hypertrophic scars (2,6–22). This treatment modality is based on the hypothesis that by selectively destroying the vascular component of hypertrophic scars clinical improvement may be seen (6,7,10). New vessel formation is essential to supply the nutrients that are necessary for the production of collagen and



Figure 1. Post-surgical scar on the chin before treatment with fractional photothermolysis.



Figure 2. Two weeks following a single treatment. Both an independent physician evaluator and the patient reported a greater than 75% improvement in the degree of erythema, induration, and overall texture of the skin.

extracellular matrices (11). However, clinical experience has shown that complete clearing of erythema and/or thickness of scars may not always be achieved, and multiple treatment sessions are usually required to obtain optimal clearing (2,8,14,15, 17–22). In some cases, hypertrophic scars are poorly responsive to pulsed dye laser irradiation (23).

One reason for this limited therapeutic outcome is postulated to be the limited light penetration depth in blood at the 585 nm wavelength, which is approximately 52 μm (absorption coefficient $\mu_a \approx 191 \text{ cm}^{-1}$) (27). Hypertrophic scars are usually several millimeters thick (28) and, as a result, deeply located blood vessels cannot be coagulated by pulsed dye laser irradiation, resulting in incomplete clearing of these lesions. Additionally, while the risk of hypertrophic scar formation is 2–14-fold higher in patients with dark skin (Fitzpatrick skin types V–VI) than those with light skin (Fitzpatrick skin types I–IV) (29), the former patient population is at a higher risk of adverse effects due to light absorption by epidermal melanin at the 585–595 nm wavelength, which can lead to post-inflammatory hyper- and hypopigmentation and texture changes to the skin (30–32).

The 1550 nm wavelength of fractional photothermolysis targets tissue water but not melanin. Therefore, it can be used on patients with all skin types. As fractional photothermolysis produces microscopic zones of thermal injury surrounded by uninjured tissue, epidermal repair is fast due to a small volume of injury and short migratory paths for keratinocytes (24). Furthermore, the stratum corneum remains intact during exposure to the 1550 nm wavelength laser as relatively less water is contained in it, and this reduces the risk of infection substantially. The 1550 nm wavelength allows a light penetration of about 1000 μm into skin ($\mu_a \approx 9.6 \text{ cm}^{-1}$ in water and blood) (33), which makes the photothermolysis of deeply located blood vessels possible and potentially a benefit compared with the pulsed dye laser which cannot penetrate to

this depth. In addition, the 'fractional', or the micro-beam-composed, laser avoids bulk heating of the skin dermis, as is the case in conventional pulsed mid-infrared lasers. For a pulse of 8 mJ and density of 2000 MTZ/cm², only approximately 15% of the treated area is actually heated. This reduces the risk of irreversible non-specific thermal injury to the dermis, which may worsen scarring. The sizes of the blood vessels in hypertrophic scars range from 3.3 to 14.6 μm (34), while the average size of the micro beam emitted from the fractional photothermolysis laser is about 100 μm in diameter. Therefore, the micro beam is sufficiently large to destroy individual blood vessels in hypertrophic scars. This presents a unique feature of fractional photothermolysis for the treatment of hypertrophic scars: on one hand, the thermal injury is small so that normal tissue repair is rapid; yet, on the other hand, the thermal injury is sufficiently large to irreversibly destroy individual blood vessels. This feature was shown by the histological results of a recent clinical study, which demonstrated the direct dermal vascular injury after the treatment of fractional photothermolysis (35). By adjusting the optical focal depth and/or the energy of fractional photothermolysis, high local radiant exposure can be achieved (24). Hence, different tissue compartments (e.g. blood vessels, dermal melanin, and sebaceous glands) at various depths of the skin can be arbitrarily selected as the targets for photothermolysis. With an appropriate MTZ density, an effective macroscopic treatment can be achieved.

Recent clinical studies on the fractional photothermolysis of surgical scars show that improvement in skin texture can be achieved in four to five treatment sessions (36,37). In this report, a greater than 75% clinical improvement was obtained after only a single treatment. The present case report suggests that fractional photothermolysis has the potential to be effective and safe in treating surgical scars. Additional studies with a larger number of patients of all skin types and with a longer-term follow-up are needed to further assess the efficacy and safety of fractional photothermolysis for the treatment of surgical scars, and to define the optimal treatment parameters.

References

- Clark JA, Leung KS, Cheng JC, Leung PC. The hypertrophic scar and microcirculation properties. *Burns*. 1996;22:447-50.
- Alster T. Laser scar revision: comparison study of 585-nm pulsed dye laser with and without intralesional corticosteroids. *Dermatol Surg*. 2003;29:25-9.
- Tredget EE, Nedelec B, Scott PG, Ghahary A. Hypertrophic scars, keloids, and contractures: the cellular and molecular basis for therapy. *Surg Clin North Am*. 1997;77:701-30.
- English RS, Shenefelt PD. Keloid and hypertrophic scars. *Dermatol Surg*. 1999;25:631-8.
- Anderson RR, Parrish JA. Selective photothermolysis: precise microsurgery by selective absorption of pulsed dye laser. *Science*. 1983;220:524-7.
- Alster TS. Improvement of erythematous and hypertrophic scars by the 585-nm flashlamp-pumped pulsed dye laser. *Ann Plast Surg*. 1994;32:186-90.
- Goldman MP, Fitzpatrick RE. Laser treatment of scars. *Dermatol Surg*. 1995;21:685-7.
- Alster TS, Williams CM. Treatment of keloid sternotomy scars with 585 nm flashlamp-pumped pulsed-dye laser. *Lancet*. 1995;345:1198-200.
- Dierickx C, Goldman MP, Fitzpatrick RE. Laser treatment of erythematous/hypertrophic and pigmented scars in 26 patients. *Plast Reconstr Surg*. 1995;95:84-90.
- Reiken SR, Wolfort SF, Berhiau F, Compton C, Tompkins RG, Yarmush ML. Control of hypertrophic scar growth using selective photothermolysis. *Lasers Surg Med*. 1997;21:7-12.
- Alster TS. Laser treatment of hypertrophic scars, keloid, and striae. *Dermatol Clin*. 1997;15:419-29.
- Alster TS, Nanni CA. Pulsed dye laser treatment of hypertrophic burn scars. *Plast Reconstr Surg*. 1998;6:2190-5.
- Shakespeare PG, Tiernan E, Dewar AE, Hambleton J. Using the pulsed dye laser to influence scar formation after breast reduction surgery: a preliminary report. *Ann Plast Surg*. 2000;45:357-68.
- Manuskiatti W, Fitzpatrick RE, Goldman MP. Energy density and numbers of treatment affect response of keloidal and hypertrophic sternotomy scars to the 585-nm flashlamp-pumped pulsed-dye laser. *J Am Acad Dermatol*. 2001;45:557-65.
- Manuskiatti W, Fitzpatrick RE. Treatment response of keloidal and hypertrophic sternotomy scars. *Arch Dermatol*. 2002;138:1149-55.
- Alster TS, Handrick C. Laser treatment of hypertrophic scars, keloids, and striae. *Semin Cutan Med Surg*. 2000;19:287-92.
- Kono T, Ercocen AR, Nakazawa H, Honda T, Hayashi H, Hayashi N, Nozaki M. The flash-pumped pulsed dye laser (585 nm) treatment of hypertrophic scars in Asians. *Ann Plast Surg*. 2003;51:366-71.
- Bowes LE, Nouri K, Berman B, Jimenez G, Pardo R, Rodriguez L, et al. Treatment of pigmented hypertrophic scars with the 585 nm pulsed dye laser and the 532 nm frequency-doubled Nd:YAG laser in the Q-switched and variable pulse modes: a comparative study. *Dermatol Surg*. 2002;28:714-19.
- Nouri K, Jimenez GP, Harrison-Balestra C, Elgart GW. 585-nm pulsed dye laser in the treatment of surgical scars starting on the suture removal day. *Dermatol Surg*. 2003;29:65-73.
- Chan HH, Wong DS, WS. HO, Lam LK, Wei W. The use of pulsed dye laser for the prevention and treatment of hypertrophic scars in Chinese persons. *Dermatol Surg*. 2004;30:987-94.
- Allison KP, Kiernan MN, Waters RA, Clement RM. Pulse dye laser treatment of burns scars: alleviation or irradiation? *Burns*. 2003;29:207-13.
- Kono T, Ercocen AR, Nakazawa H, Nozaki M. Treatment of hypertrophic scars using a long-pulsed dye laser with cryogen-spray cooling. *Ann Plast Surg*. 2005;54:487-93.
- Wittenberg GP, Fabian BG, Bogomilsky JL, Schultz LR, Rudner EJ, Chaffins ML, et al. Prospective, singleblind, randomized, controlled study to assess the efficacy of the 585-nm flashlamp-pumped pulsed-dye laser and silicone gel sheeting in hypertrophic scar treatment. *Arch Dermatol*. 1999;135:1049-55.
- Manstein D, Herron GS, Sink RK, Tanner H, Anderson RR. Fractional photothermolysis: a new concept for cutaneous remodeling using microscopic patterns of thermal injury. *Laser Surg Med*. 2004;34:426-38.
- Khan MH, Sink RK, Manstein D, Eimerl D, Anderson RR. Intradermally focused laser pulses: thermal effects at defined tissue depths. *Laser Surg Med*. 2005;36:270-80.

26. Fitzpatrick TB. The validity and practicality of sun-reactive skin types I through VI. *Arch Dermatol.* 1988;124:869–71.
27. Van Gemert MJC, Welch AJ, Pickering JW, Tan OT. Laser treatment of port wine stains. In: Welch AJ, van Gemert MJC, editors. *Optical-thermal response of laser-irradiated tissue.* New York: Plenum Press; 1995. p. 789–830.
28. Hambleton J, Shakespeare PG, Pratt BJ. The progress of hypertrophic scars monitored by ultrasound measurements of thickness. *Burns.* 1992;18:30–7.
29. Alhady SM, Sivanantharajah K. Keloids in various races: a review of 175 cases. *Plast Reconstr Surg.* 1969;44:564–6.
30. Ashinoff R, Geronemus RG. Treatment of port-wine stain in a black patient with pulsed dye laser. *Dermatol Surg Oncol.* 1992;18:147–8.
31. Hædersdal M, Cniadecka M, Efsen J, Bech-Thompsen N, Keiding J, Wulf HC. Side effects from the pulsed dye laser: the importance of skin pigmentation and skin redness. *Acta Derm Venereol.* 1998;78:445–50.
32. Sommer S, Sheehan-Dare RA. Pulsed dye laser treatment of port-wine stains in pigmented skin. *J Am Acad Dermatol.* 2000;42:667–71.
33. Irvine WM, Pollack JB. Infrared optical properties of water and ice spheres. *Icarus.* 1968;8:324–60.
34. Kischer CW, Thies AC, Chvapil M. Perivascular myofibroblasts and microvascular occlusion in hypertrophic scars and keloids. *Hum Pathol.* 1982;13:819–24.
35. Laubach HJ, Tannous Z, Anderson RR, Manstein D. A histological evaluation of the dermal effects after fractional photothermolysis treatment. *Lasers Surg Med.* 2005;36(S17):86.
36. Rokhsar CK, Tse Y, Fitzpatrick R. Fractional photothermolysis on the treatment of scars. *Lasers Surg Med.* 2005;36(S17):30.
37. Fisher GH, Kim KH, Bangesh S, Bernstein LJ, Skover G, Geronemus RG. Treatment of surgical scars with fractional photothermolysis. *Lasers Surg Med.* 2005;36(S17):81.