

Comparative Studies of Superficial and Deep Resurfacing Using the UltraPulse® CO₂ Laser and Erbium:YAG Laser in Photodamaged Skin

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Introduction

The relative roles of CO₂ and Erbium:YAG lasers in cosmetic skin resurfacing have been studied for over two years. Initial studies indicated faster healing times with Erbium:YAG compared to CO₂; conclusions varied, however, regarding efficacy. Contributing to this range of results was the variation in relative depths of CO₂ and Erbium resurfacing.

To provide a controlled comparison, the following studies examined Erbium and CO₂ resurfacing when the total depth of injury produced was equivalent. Specifically, these studies evaluated healing times and efficacy when: 1) deep CO₂ was compared to a histologically equivalent depth of deep Erbium resurfacing and 2) superficial CO₂ was compared to a histologically equivalent depth of superficial Erbium resurfacing.

Deep Resurfacing with Equivalent Depths of CO₂ and Erbium

A recent bilateral study compared CO₂ and Erbium lasers when the depth of CO₂ coagulative necrosis was equal to the depth of Erbium:YAG ablation in deep facial resurfacing.^{1,2} Results demonstrate that postoperative healing times are similar when equivalent depths of injury are produced with CO₂ and Erbium.

Methods

Standard CO₂ resurfacing was compared with deep but histologically equivalent Erbium:YAG resurfacing in 20 patients. Histologic studies have shown that 1 pass of Erbium at 5.0 J/cm² will ablate approximately 20 microns of tissue.^{3,4} Three or four passes using a pulsed (UltraPulse®) CO₂ laser at 300 mJ, pattern density 5, produces 250 to 300 microns of tissue effect in the form of ablation and residual thermal coagulation.⁵ To create the same level of injury, 240 to 300 microns of ablation, 12 to 15 passes of Erbium at 5.0 J/cm² were used. Erbium and CO₂ laser parameters are outlined in Table 1.

Table 1. Laser parameters used for bilateral comparative deep resurfacing study.

	Fluence/ Energy	Spot Size	Number of Passes	Depth of Injury
Erbium Left Face	5.0 J/cm ²	5 mm	12 – 15 (no wiping between passes)	240-300 µm (Ablative)
CO ₂ Right Face	300 mJ 7.5 J/cm ²	2.25 mm, CPG Pattern Density 5	3 – 4 (wiping between passes)	250-300 µm (Coagulative)

Results

Study results are outlined in Table 2. In all cases, with the exception of mild perioral rhytids, the CO₂ produced a superior aesthetic result (Figures 1A-C). For superficial rhytids, the aesthetic results were comparable (Figures 2A, 2B).

Table 2. Efficacy of CO₂ vs. Erbium for deep resurfacing.

	Time to Re-Epithelialize	Postoperative Erythema	Pain	Aesthetic Outcome
Erbium	8-10 days	4-12 weeks	As painful, or more compared to CO ₂ .	Erbium and CO ₂ equivalent for superficial rhytids. CO ₂ superior for moderate to severe rhytids.
CO ₂	10-12 days	4-12 weeks	As painful, or less compared to Erbium.	

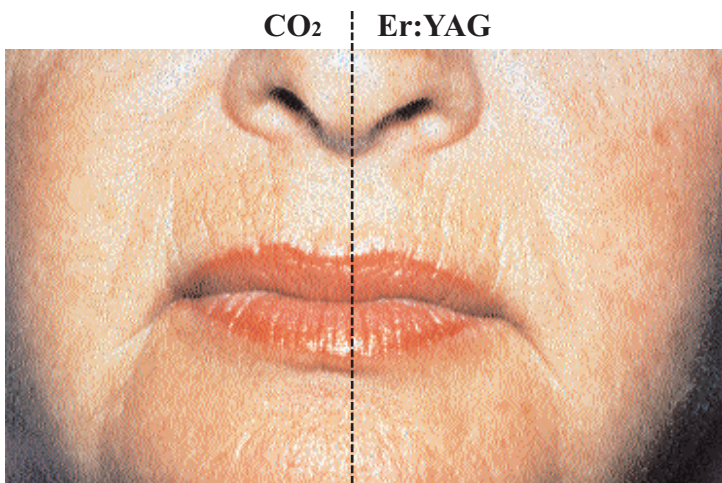


Figure 1A



Figure 1B



Figure 1C

Figures 1A, B and C. DEEP RESURFACING
Erbium Parameters: 12-15 passes, 5.0 J/cm², 5 mm spot, no wiping between passes – Viewer's Right.
CO₂ Parameters: 3-4 passes, 300 mJ, pattern density 5, wiping between passes – Viewer's Left.
 A) Upper lip rhytids preop; B) 8 weeks postop; and C) 8 months postop. CO₂ resurfacing (viewer's left) and Erbium:YAG resurfacing (viewer's right) were achieved with equal depths of CO₂ coagulative necrosis and Erbium ablation. The CO₂ side shows a superior aesthetic outcome.

CO₂ | Er:YAG

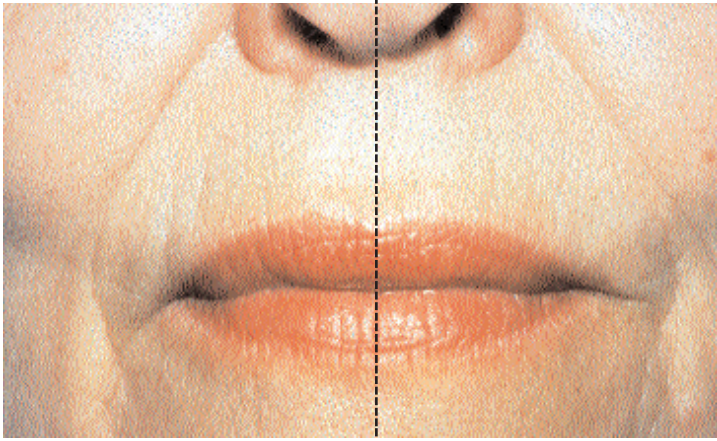


Figure 2A



Figure 2B

Figures 2A and B. DEEP RESURFACING

Erbium Parameters: 12-15 passes, 5.0 J/cm², 5 mm spot, no wiping between passes – Viewer's Right.

CO₂ Parameters: 3-4 passes, 300 mJ, pattern density 5, wiping between passes – Viewer's Left.

A) Fine upper lip rhytids preop and B) 8 weeks postop. CO₂ resurfacing (viewer's left) and Erbium:YAG resurfacing (viewer's right) were achieved with equal depths of CO₂ coagulative necrosis and Erbium ablation. Similar efficacy for the treatment of fine rhytids is noted.

Superficial Resurfacing with Equivalent Depths of CO₂ and Erbium

A second bilateral study compared superficial CO₂ laser coagulation to an equivalent depth of Erbium:YAG laser ablation. The results demonstrate that single-pass CO₂ resurfacing is safe and equally effective when compared to superficial resurfacing with the Erbium:YAG laser.

Methods

Excised tissue was treated with both the CO₂ and Erbium:YAG lasers and examined histologically to verify that laser parameters chosen for the study would produce equivalent depths of tissue injury. The first sample was treated with one pass using an UltraPulse CO₂ laser and CPG set at 100 mJ per pulse and pattern density ⁵. Histologic examination showed full thickness epidermal coagulation (Figure 3). A second sample was treated with five pulses from the Erbium:YAG laser with fluence per pulse of 5 J/cm². The histology showed complete epidermal ablation with little thermal residual (Figure 4). These data verified that the laser parameters selected were appropriate to achieve equivalent depths of tissue injury.

Eight patients with photodamaged skin were treated with superficial CO₂ resurfacing on one side of the face and equivalent Erbium:YAG laser resurfacing on the other. CO₂ and Erbium laser parameters are outlined in Table 3. Anesthesia was achieved with local injections or nerve blocks. Clinical efficacy, healing course, and postoperative complications were documented and pre- and postoperative photos were obtained.

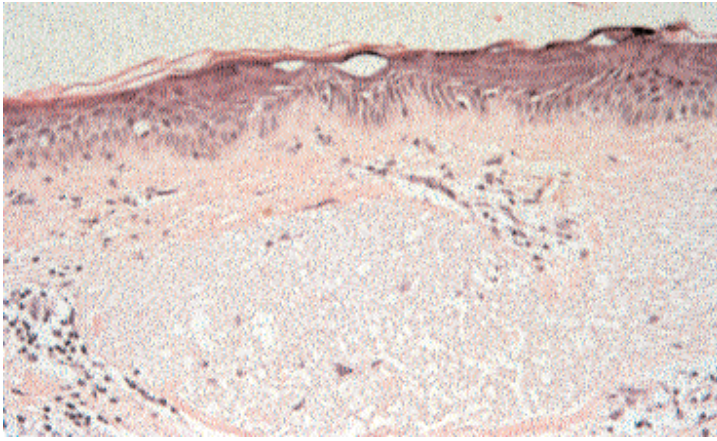


Figure 3

Figure 3. SUPERFICIAL RESURFACING

CO₂ Parameters: 1 pass, 100 mJ, pattern density 5, no wiping after pass.

Histologic effects of a single scan of CO₂ showing approximately 100 μm epidermal coagulation with little or no thermal residual in the dermis (far right of photo) and adjacent normal epidermis (far left of photo).

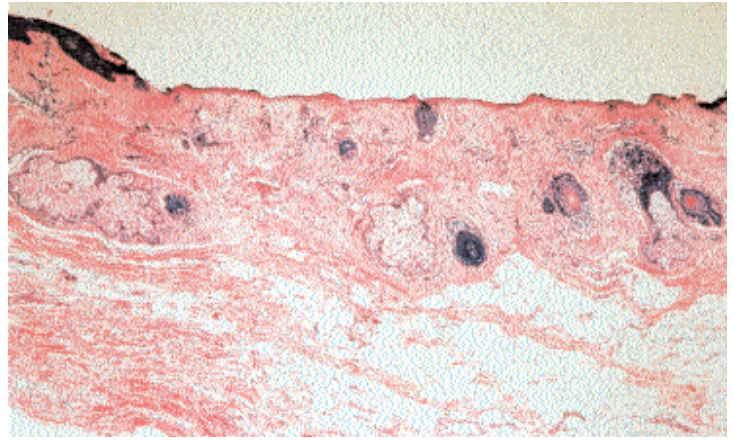


Figure 4

Figure 4. SUPERFICIAL RESURFACING

Erbium Parameters: 5 passes, 5.0 J/cm², 5 mm spot, no wiping between passes.

Histologic effects of 5 passes Erbium:YAG showing approximately 100 μm of ablation with 20 μm of thermal residual in the upper dermis.

Table 3. Laser parameters used for bilateral comparative superficial resurfacing study.

	Fluence / Energy	Spot Size	Number of Passes	Depth of Injury
Erbium Right Face	5.0 J/cm ²	5 mm	5 (no wiping between passes)	approx. 100 μm (Ablative)
CO ₂ Left Face	100 mJ 2.5 J/cm ²	2.25 mm, CPG Pattern Density 6	1 (no wiping after pass)	approx. 100 μm (Coagulative)

Results

Study results are outlined in Table 4. No significant differences were noted in discomfort, post-operative erythema, time to re-epithelialize, or efficacy between the Erbium:YAG and CO₂ treatment sides (Figures 5A-D and 6A-D).

Table 4. Efficacy of CO₂ vs. Erbium for superficial resurfacing.

	Time to Re-Epithelialize	Postoperative Erythema	Pain	Aesthetic Outcome
Erbium	5-7 days	2-3 weeks	Erbium and CO ₂ equivalent.	Erbium and CO ₂ equivalent.
CO ₂	5-7 days	2-3 weeks		



Figure 5A

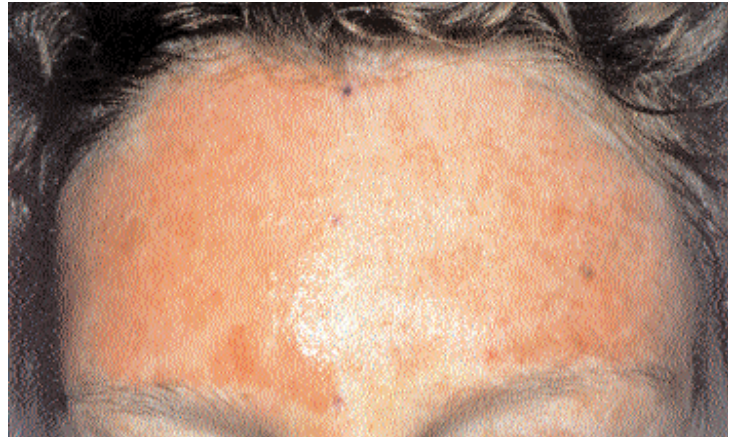


Figure 5B



Figure 5C



Figure 5D

Figures 5A, B, C and D. SUPERFICIAL RESURFACING

Erbium: 5 passes, 5.0 J/cm², 5 mm spot, no wiping between passes – Viewer's Left.

CO₂: 1 pass, 100 mJ, pattern density 6, no wiping after pass – Viewer's Right.

59 year-old female. A) Preop forehead photo; B) 1 day postop; C) 1 week postop and D) 4 weeks postop.

No significant difference was noted in healing or aesthetic outcome.

Er:YAG | CO₂



Figure 6A

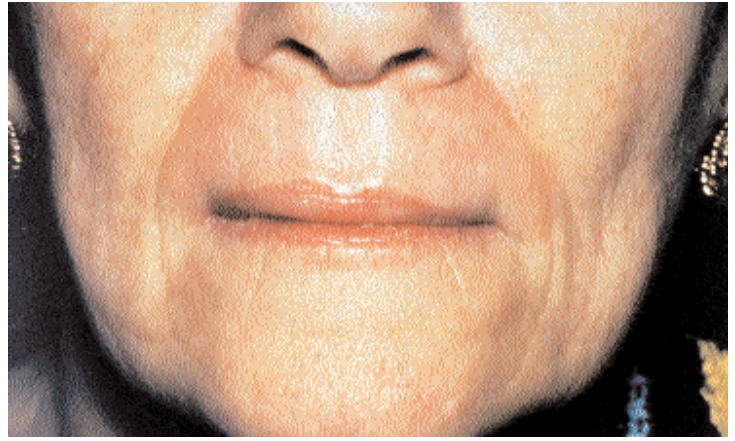


Figure 6B



Figure 6C



Figure 6D

Figures 6A, B, C and D. SUPERFICIAL RESURFACING

Erbium: 5 passes, 5.0 J/cm², 5 mm spot, no wiping between passes – Viewer's Left.

CO₂: 1 pass, 100 mJ, pattern density 6, no wiping after pass – Viewer's Right.

65 year-old female. A) Preop upper lip rhytids; B) 1 week postop; C) 2 weeks postop; and D) 8 months postop. No difference in healing was noted clinically. Very little improvement of severe rhytids is noted on either the Erbium or CO₂ treatment side. This patient is a candidate for deep CO₂ resurfacing.

Discussion

The results from these comparative studies do not support the general view that Erbium:YAG lasers offer greater safety and faster healing when compared to CO₂ lasers.

The first study demonstrated that deep resurfacing with Erbium does not compare to CO₂ for the treatment of medium to severe rhytids. When standard CO₂ resurfacing was compared to deep but histologically equivalent Erbium:YAG resurfacing, the time to re-epithelialize, post-op erythema and pain were similar. The aesthetic outcome was equivalent for superficial rhytids; however, for moderate to severe rhytids, CO₂ produced an aesthetically superior result.

The second bilateral study comparing superficial CO₂ laser coagulation to an equivalent depth of Erbium:YAG laser ablation demonstrated that both healing times and aesthetic results were similar for single pass CO₂ resurfacing and superficial Erbium:YAG resurfacing. This result is reasonable, since equivalent depths of histologic damage whether coagulative (CO₂) or ablative (Erbium:YAG) should lead to similar postoperative healing.

In summary, Erbium:YAG lasers do not promote faster healing or provide greater safety than CO₂ lasers when used to produce the same anatomical level of thermal injury. For deep resurfacing of moderate to severe rhytids, CO₂ lasers produce an aesthetically superior result. In addition, superficial CO₂ laser resurfacing is a viable, clinically proven modality for areas usually treated with Erbium:YAG. By following the guidelines for energy (100-125 mJ), pattern density (5 to 6), and single scans, pulsed CO₂ lasers are a safe and effective technology for superficial skin resurfacing.

References

1. Adrian, RM: A Clinical and Histologic Comparison of Erbium:YAG and Pulsed Carbon Dioxide Lasers in the Treatment of Facial Rhytids. *Lasers in Surgery and Medicine*. 10:38, 1998.
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3. Walsh, JT, Deutsch, TF: Er:YAG Laser Ablation of Tissue: Measurement of Ablation Rates. *Lasers in Surgery and Medicine*. 9:327-337, 1989.
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