Atrophic Scar Revision Using Fractional Photothermolysis

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With their ability to deliver controlled thermal damage in order to stimulate deep dermal remodeling, laser devices are widely considered to be versatile and effective tools for the treatment of atrophic scarring. However, despite the capabilities and technological characteristics of laser modalities in general, the limited efficacy of nonablative laser devices and the adverse effects associated with traditional ablative laser systems suggest that a new modality for the treatment of atrophic scars is needed.

Forty subjects with Fitzpatrick skin types I through VI received 3 to 5 treatments with the Fraxel® SR Laser System. A total of 53 atrophic scars (acne, surgical, traumatic, and striae) were treated.

For 62.3% of the scars, overall appearance was moderately to completely improved at 1-month and 3-month follow-up visits. Three months posttreatment, overall scar severity was significantly reduced ($P<.001$), and erythema was absent in all subjects.

Because 4 different scar types with unique etiologies were treated, comparisons among subgroups were limited. Sites treated with the Fraxel SR Laser System were not compared with untreated control sites.

Fractional photothermolysis with the Fraxel SR Laser System safely reduced the severity of acne, surgical, traumatic, and striae scars and improved color mismatch, surface texture, and atrophy.

Atrophic scars are depressions in epidermal and dermal tissue. They most commonly result from surgical procedures, traumatic injury, or excessive internal cutaneous tension.[1] Like photodamaged skin, atrophic scars are associated with reduced amounts of collagen and irregularly structured fibers in the dermis. They may also lack elasticity.

Traditional treatments of atrophic scars, such as dermabrasion, chemical peels, excisional surgery, punch grafting, and tissue augmentation with dermal fillers, may be efficacious for improving certain characteristics of atrophic scars but are often limited by a high likelihood of scarring, fibrosis, incomplete removal of lesions, infection, poor visualization during the procedure, and permanent pigmentary changes.[2-5]

To improve skin tone and texture in atrophic scars, researchers have used ablative and nonablative resurfacing procedures, both known to stimulate collagen remodeling and dermal reorganization in photodamaged skin.[4,6-9] Ablative procedures provide greater clinical improvement than nonablative procedures, but the risk of posttreatment complications is higher.[8] The limited efficacy of nonablative procedures and the adverse effects of ablative techniques suggest that a new modality for the treatment of atrophic scars is needed.

Recent studies suggest that fractional photothermolysis (FP) may be a safe and effective modality for the treatment of atrophic scars of various etiologies.[10-13] In FP, an array of tiny thermal wounds called *microscopic treatment zones* (MTZs) are created while sparing the tissue surrounding each wound. MTZs have specific 3-dimensional arrangements and appear

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TABLE 1

Average Age and Location of Scars and Treatment Parameters for Scars Treated by Fractional Photothermolysis*

Parameter (mean±SD, where applicable)	Scar Type				
	Acne (n=14)	Surgical (n=11)	Traumatic (n=13)	Striae (n=15)	All Scars (n=53)
Anatomic location	Face (cheeks, temple, chin, perioral area, forehead, temporal area), chest	Face, abdomen, forearm, thigh, elbow	Face (chin, cheeks, forehead), neck, forearm, arm, thigh, shin, back	Trunk (anterior or posterior; hips, buttocks, abdomen, back), thighs	NA
Age, mo	123.3±81.1	92.4±69.0	190.9±210.8	111.5±84.2	NA
Energy, mJ	11.6±4.6	14.3±4.7	13.0±5.3	12.6±5.4	11.8±4.6
Density, MTZ/cm^2	2058.0±856.5	1818.8±782.0	2317.3±1105.0	2010.4±831.2	2038.4±905.2

*NA indicates not applicable.

at depths in the skin that can be controlled by the energy output of the laser.[9] Rokhsar and colleagues[13] presented histologic evidence of collagen remodeling in scarred tissue and showed improvement in acne scars, surgical scars, and skin texture after FP treatment. Kim and colleagues[10] reported subjective and objective improvement in acne scars, while Bernstein and colleagues[12] described improvements in striae distensae treated similarly. The apparent utility of this system may be due to the controlled delivery of microscopic zones of photothermolysis, a departure from the traditional principles of selective photothermolysis, which results in targeted absorption by specific chromophores. The Fraxel® SR Laser System is the only FP system cleared for the treatment of pigmented lesions, periorbital rhytides, skin resurfacing, melasma, acne scars, surgical scars, and soft tissue coagulation.

The purpose of this study was to evaluate the efficacy and safety of the Fraxel SR Laser System in the treatment of atrophic scars (acne, surgical, traumatic, and striae). Results have been reported previously in abstract form.[14]

METHODS

Subjects

Forty subjects (36 women) aged 23 to 56 years (mean, 38.4±10.1 years) with Fitzpatrick skin types I through VI enrolled in the study. Scars to be treated (up to 2 per subject) were identified and classified as to type and severity. Changes in severity were scored on a scale of 0 to 9 based on photographs taken before and after treatments. Overall scar severities were placed into 3 categories on the basis of the average individual characteristic scores: mild (I), moderate (II), and severe (III). Each category was associated with the numerical average of color mismatch, surface texture abnormality, and atrophy scores (average scores: no scarring characteristic=0, mild=1–3, moderate=4–6, severe=7–9). Through use of this classification system, 53 long-standing scars (acne, surgical, traumatic, and striae) of at least moderate severity (on a scale of 0–9) were identified for treatment with the Fraxel SR Laser System. The ages and locations of scars are shown in Table 1. The study was approved by the Western Institutional Review Board of Olympia, Wash. All subjects provided signed informed consent. Exclusion criteria included active local or systemic infection; a history of atopic dermatitis or keloid scarring; allergy to lidocaine; a history of isotretinoin therapy within 1 year preceding enrollment; smoking at the time of the study; and treatments with lasers, chemical procedures, botulinum toxin injections, soft tissue filler injections, or other cosmetic procedures within 1 year preceding enrollment.

Treatment Procedure

Scars were washed, wiped with isopropyl alcohol (70%), and allowed to dry. Topical anesthetic was applied for

45 minutes to 1 hour and removed with gauze. To facilitate tracking the handpiece during FP treatment, blue dye solution was applied to each scar and allowed to dry for approximately 1 minute.

Subjects received 3 to 5 laser treatments at approximately 2.5-week intervals (16.5±5.2 days). Low-energy treatments (≤10 mJ) were delivered at a high density (2000–4000 MTZ/cm^2), and high-energy treatments (>10 mJ) were delivered at a low density (1000–1750 MTZ/cm^2). Each treatment consisted of at least 8 passes ranging from 125 to 250 MTZ/cm^2 and lasting 20 minutes each on average. Treatment parameters for each scar type are shown in Table 1.

Clinical outcomes and adverse effects were evaluated approximately 1 month (33.0±8.6 days) and 3 months (99.1±15.5 days) after the final treatment.

Efficacy Evaluation

For all types of scars, subjects and the study investigator assessed improvements in skin texture, pigmentation, topography (depression or perceptible height differences), and overall scar appearance at the 1-month and 3-month follow-up visits. They scored improvements on a scale of 0 to 4 (0=none, 1=mild, 2=moderate, 3=significant, 4=very significant or total improvement).

In addition, 2 independent blinded investigators evaluated changes in the severity of 3 characteristics of scars: (1) color mismatch, (2) surface texture abnormality, and (3) atrophy. Labeling of the baseline and follow-up photographs combined an alphanumeric subject identification number with an alphanumeric code representing the corresponding study visit. The independent investigators were blinded to the alphanumeric coding system and were provided with a table to record their evaluations of each photograph.

Color mismatch was assessed by observing discrepancies between scarred areas and surrounding tissue (hypopigmented [whitened] or hyperpigmented [red, purple, yellow]). Surface texture abnormality assessments were based on changes in skin laxity, tension, wrinkling, and shine. Atrophy was judged by flatness, depression, or profilometry. Following assessment of photographs taken before and after treatments, changes in severity were scored according to the severity scale of 0 to 9 described previously. For example, mild overall severity corresponded to an average score between 1 and 3 in which changes in color mismatch, surface texture abnormality, and atrophy were slight.

Safety Evaluation

The study investigator assessed changes in erythema, edema, pigmentation abnormality, and crusting 2 weeks after the first treatment session, at each subsequent session, and at each follow-up visit. Changes were scored on a scale of 0 to 3 (0=none, 1=mild, 2=moderate, 3=severe).

Statistics

Data were analyzed with statistical software. To test for statistically significant differences, *t* tests were performed. Sample-size calculations were performed on the basis of the variance of scar severity scores to confirm the appropriate population sizes for each scar subgroup. Paired *t* tests were used to assess the relationships between scar type and independent investigator improvement scoring.

RESULTS

Efficacy

For 63.5% (33 of 52) of scars assessed at 1 month posttreatment, overall appearances were moderately to completely improved (scores ≥2) at 1-month follow-up visits. For all but 1 patient, improvements persisted through the 3-month visit, at which time improvements were moderate to complete in 61.5% (32 of 52) of scars. Subjects reported relatively higher improvement in surface texture and topography of scars than in pigmentation. Subject- and investigator-assessed improvements in these characteristics as well as overall scar appearance at 3-month follow-up visits are shown in Table 2.

Study investigator assessments indicated that topography, skin texture, and overall appearance improved in more than 50% of treated scars at 1 month and 3 months (data shown only for 3-month visits in Table 2). At 3 months, improvements in striae were lower compared with other scar types (data not shown). For all scar types, pigmentation improvements were highest 1 month after treatment. Study investigators determined that 44.9% (22 of 49) of scars were moderately to completely improved in overall appearance at 3 months. Interestingly, as evidence of the high subject satisfaction, subjects reported moderate to complete improvement 3 months posttreatment for 61.5% (32 of 52) of scars treated.

Blinded investigator evaluations of 3-month improvements in scar severity are shown in Table 3. Improvement occurred if a blinded investigator assigned a lower scar-severity score to the posttreatment photograph than to the baseline photograph. In this case, the scar-severity improvement score was greater than 0. Photographs of poor quality, such as those with poor lighting or imprecise patient positioning, were not included in the analysis.

Blinded investigator scar characteristic severity scores were averaged to obtain an overall baseline score (4.45±1.32) and a 3-month score (3.22±1.36). At 3 months, overall scar severity was reduced to 1.23±1.1

TABLE 2

Percentage of Scars Improved (Score ≥2) as Determined by the Subject and Study Investigator 3 Months Posttreatment

Parameter	Subject Assessment: Improvement ≥2, n/total (%)	Study Investigator Assessment: Improvement ≥2, n/total (%)
Topography	20/52 (38.5)	31/52 (59.6)
Skin Texture	35/52 (67.3)	32/53 (60.4)
Pigmentation	20/52 (38.5)	11/53 (20.8)
Overall Scar Appearance	32/52 (61.5)	22/49 (44.9)

on the scale of 0 to 9, a statistically significant difference ($P<.001$) (Table 3).

As scored by the study investigator, however, baseline severity for the 53 treated scars was 5.7±1.4 (mean±SD), higher than the 4.45±1.32 arrived at by independent investigators. The difference was attributed to interpretative variations in photographs versus face-to-face contact. Since (1) the primary end point of this study was reduction in scar severity as determined independently by blinded investigators and (2) different assessment procedures and scales were used within the study protocol, no direct comparisons were made between study investigator and blinded investigator scoring using the same scale.

Individual scoring of color mismatch, surface texture abnormalities, and atrophy confirmed categorical improvements among scar types (Table 3). The relatively lower (>1) improvement in color mismatch (1.04±1.3) compared with surface texture abnormalities and atrophy may be due to mild, late-onset, postinflammatory pigmentary changes. Such transient pigmentary changes may have compromised the investigators' ability to quantify improvement in scar-associated color mismatch.

In each scar type, the mean overall reduction in scar severity was statistically significant, as shown by *t* test comparisons of 3-month and baseline overall severity data (Table 3). Improvement scores were highest in surgical scars (1.81±0.94, $P=.0004$) and acne scars (1.37±1.3, $P=.0011$) and lowest in traumatic scars (0.87±0.9, $P=.0024$). For every scar characteristic, the average improvement scores for acne scar and surgical scar exceeded 1 point. Acne scars showed the highest improvement in color mismatch, whereas surgical scars had the greatest improvement in surface texture abnormalities and atrophy. Clinical examples of surgical and acne scars treated by FP are shown in Figures 1 through 4.

Among scar types, traumatic scars showed the least improvement in skin texture abnormalities, probably owing to the large discrepancy between the skin texture scores of the 2 blinded investigators. The discrepancy in skin texture assessments may also have contributed to the reduction in overall improvement within the traumatic scar subgroup, with respect to the surgical scar subgroup. In skin texture assessment, blinded investigators were required to evaluate a 3-dimensional characteristic (skin texture) from 2-dimensional photographs, which was a difficult task. The traumatic scars treated in this study had many causes and etiologies, and treatment results had more inherent topographic variability than results for surgical scars of similar, linear geometries. Face-to-face comparisons by the study investigator showed that 53% (7 of 13) of traumatic scars had at least moderate improvement in skin texture abnormalities. Further investigation will address the mechanisms of improvement in the wide range of traumatic scars treated.

Based on the 47 scars assessed 3 months posttreatment, frequency distributions for overall scar severity improvements greater than 0 and greater than 1 are shown in Table 4. For each improvement level, the events in which (1) investigator 1 and investigator 2 independently reported improvement in overall scar severity and (2) at least 1 investigator reported improvement are shown. At least 1 investigator reported improvement greater than 0 in 91% of scars and greater than 1 in 79% of scars.

Surgical scars were the most likely to show reduction in scar-severity score of at least 1. One hundred percent of surgical scars received improvement scores of 1 or higher by at least 1 investigator. As to overall scar severity, at least 69% of acne, traumatic, and striae scars showed score reductions of at least 1. Consistent with subject and study investigator assessments described earlier,

TABLE 3

Improvement Scores (Mean±SD) in Color Mismatch, Surface Texture Abnormalities, and Degree of Atrophy 3 Months After Final Fractional Photothermolysis Treatment

	All Scars (n=47)	Acne (n=13)	Surgical (n=9)	Traumatic (n=13)	Striae (n=12)
Color mismatch					
Investigator 1	1.43±1.6	1.69±1.6	1.77±2.0	1.31±1.3	1.00±1.5
Investigator 2	0.66±1.6	0.84±1.6	0.67±2.5	0.53±1.5	0.58±1.5
Mean±SD*	1.04±1.3	1.26±1.3	1.22±1.1	0.93±1.2	0.79±1.3
Surface texture abnormalities					
Investigator 1	1.94±1.5	2.00±1.8	2.67±1.2	1.46±0.9	1.83±1.7
Investigator 2	0.68±1.5	1.08±2.0	1.11±0.9	-0.15±1.4	0.83±1.2
Mean±SD*	1.30±1.4	1.53±1.8	1.89±0.9	0.65±1.0	1.33±1.3
Degree of atrophy					
Investigator 1	1.87±1.75	1.84±1.9	2.77±1.6	1.46±1.4	1.66±1.8
Investigator 2	0.91±1.5	1.08±1.4	1.33±1.9	0.76±1.5	0.59±1.5
Mean±SD*	1.39±1.3	1.46±1.6	2.05±1.6	1.12±1.5	1.12±1.4
Overall severity					
Investigator 1	1.75±1.4†	1.78±1.5†	2.58±1.4†	1.41±0.8†	1.44±1.6†
Investigator 2	0.72±1.1†	0.97±1.3†	1.04±1.1†	0.33±1.9‡	0.64±1.0§
Mean±SD*	1.23±1.1†	1.37±1.3†	1.81±0.94†	0.87±0.9†	1.04±1.0†

*For investigators 1 and 2.

†Statistically significant reduction ($P<.05$) according to paired *t* test. The pretreatment and posttreatment data were tested for statistically significant reductions. The mean and SD or the reductions in scores are shown.

‡Reduction in scar severity within scar type observed but not statistically significant ($P=.30$, paired *t* test).

§Reduction in scar severity within scar type observed but not statistically significant ($P=.065$, paired *t* test).

improvement rates of striae and traumatic scars were lower than rates for acne and surgical scars.

In Table 4, scoring of the blinded investigators was presented individually and in combination to minimize the effects of incongruence among study investigator assessments and incongruence associated with blinded investigator analysis of photographs.[15] Since individual investigators may emphasize different characteristics, their scoring should be reviewed independently and simultaneously.

Safety

Posttreatment adverse effects during the follow-up period were evaluated by the study investigator (Table 5). Erythema was mild or absent in all subjects at the 1-month and 3-month follow-up visits. Thirty-five subjects (87.5%) had no erythema during each assessment. Five (12.5%) experienced mild erythema 1 month after the final FP treatment. Erythema had resolved in all subjects 3 months after their final treatments. Seven subjects (17.5%) experienced mild erythema (severity score ≤1) during 1 or more posttreatment evaluations. Persistent edema was not observed in any subject during the treatment and follow-up periods.

To monitor postinflammatory hyperpigmentation (PIH) during the study period, PIH onset was categorized as early or late. Early-onset PIH was initially observed during a treatment visit, whereas late-onset PIH was seen for the first time during a follow-up visit. Early-onset PIH was observed in 13 subjects, whereas 7 subjects presented

TABLE 4

Frequency Distributions for Improvements Greater Than 0 and Greater Than 1 in Overall Scar Severity 3 Months After the Final Fractional Photothermolysis Treatment*

	All Scars, n/total (%)	Acne, n/total (%)	Surgical, n/total (%)	Traumatic, n/total (%)	Striae, n/total (%)
Improvement >0					
Investigator 1†	39/47 (83)	11/13 (85)	9/9 (100)	12/13 (92)	9/12 (75)
Investigator 2†	31/47 (66)	9/13 (69)	8/9 (89)	4/13 (31)	8/12 (67)
Either‡	43/47 (91)	12/13 (92)	9/9 (100)	12/13 (92)	10/12 (83)
Improvement >1					
Investigator 1†	36/47 (77)	9/13 (69)	8/9 (89)	10/13 (77)	9/12 (75)
Investigator 2†	22/47 (47)	8/13 (62)	5/9 (56)	4/13 (31)	5/12 (42)
Either‡	37/47 (79)	9/13 (69)	9/9 (100)	10/13 (77)	9/12 (75)

*At the 3-month follow-up visit, 47 scars were assessed.

†Events in which individual investigator independently reported improvement in overall appearance of scar.

‡Events in which either investigator reported improvement in overall appearance of scar.

with late-onset PIH. Average PIH severity was slight to mild in most subjects (Table 5). The number of treatments and treatment parameters were comparable among the early-onset, late-onset, and no-PIH subgroups.

Early-onset PIH was observed in 13 subjects in whom all Fitzpatrick skin types were represented (type I, n=1; type II, n=3; type III, n=3; type IV, n=4; type V, n=1; type VI, n=1). In 12 subjects, PIH showed improvement (ie, appeared lighter) 1 month after the final treatment. In the remaining subject, in whom PIH did not appear until the final of 5 treatments, improvement was first observed at the 3-month follow-up visit. This subject's scar was a postsurgical scar on the abdomen.

Late-onset PIH was observed only in subjects of Fitzpatrick skin types II, III, and IV. Of these 7 subjects, PIH was first observed at 1 month in 4 subjects and at 3 months in 3 subjects. Late-onset PIH was observed in subjects with acne (n=1), surgical (n=1), traumatic (n=3) and striae (n=4) scars. Since late-onset PIH was observed in these subjects in midsummer and early fall, it may be attributable to noncompliance with posttreatment instructions to avoid or protect treated areas from sun exposure. In 1 subject (no PIH), erythematous patches were observed in the treated area during the treatment 4 visit. This condition was not observed during treatment 5 and subsequent follow-up visits and was attributed to a possible flare-up of psoriasis.

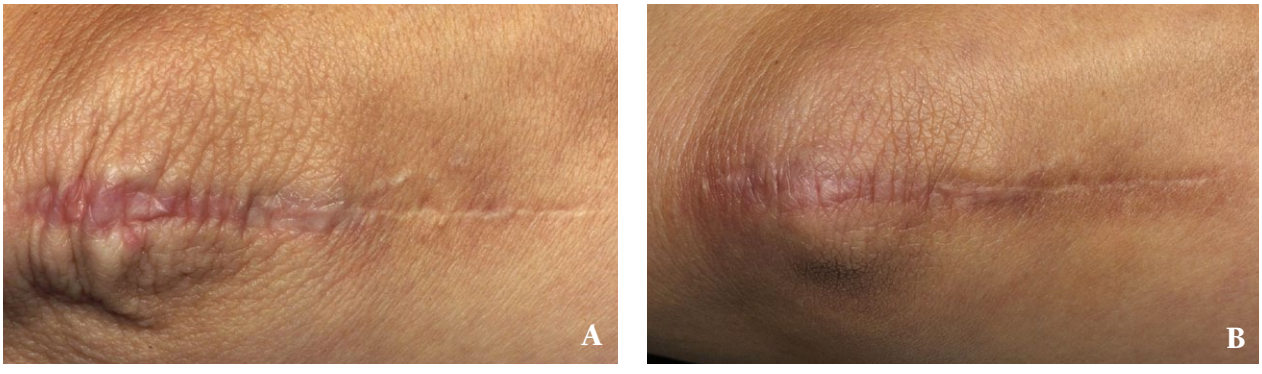

Figure 1. A surgical scar on the elbow of a 46-year-old woman (Fitzpatrick skin type II) before (A) and 3 months after (B) the final of 4 treatments with the Fraxel® SR Laser System at 15 mJ and 1500 MTZ/cm². MTZ indicates microthermal zone. Photographs courtesy of Zakia Rahman, MD.

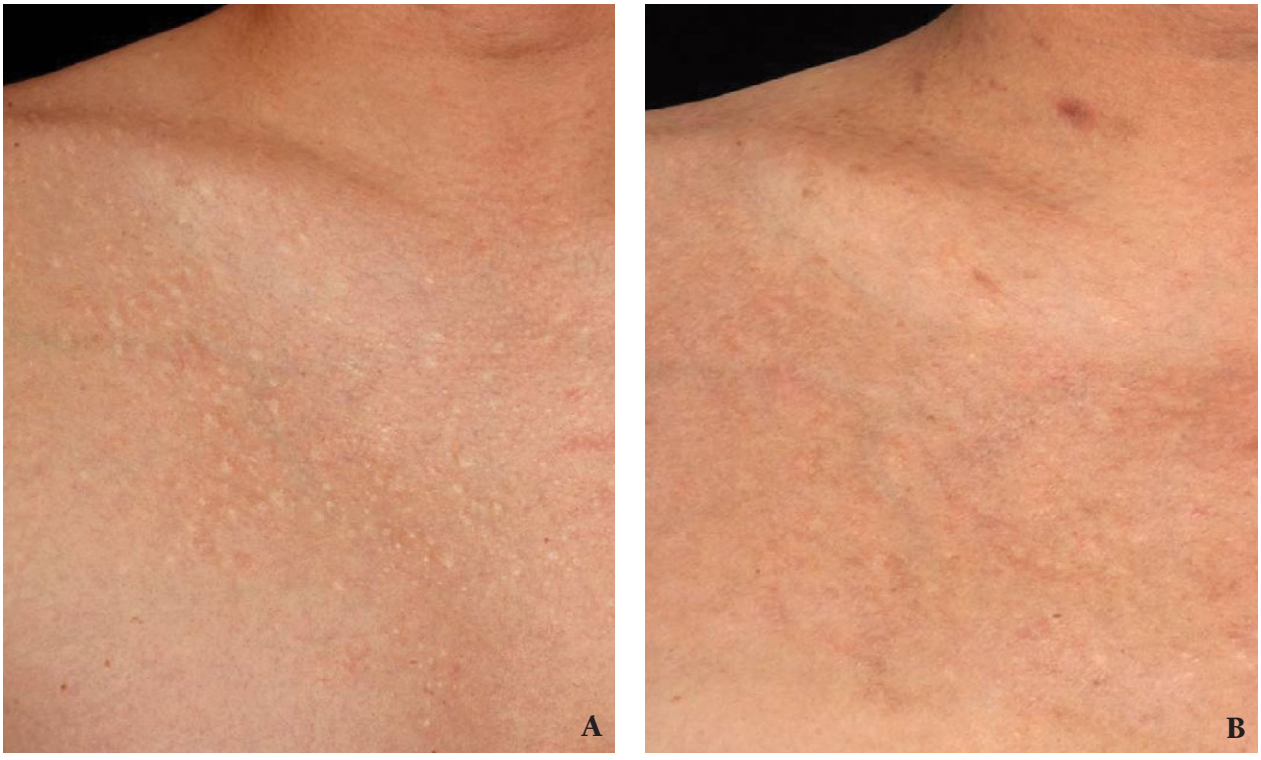

Figure 2. A 26-year-old woman (Fitzpatrick skin type V) with severe acne scars before (A) and 3 months after (B) the final of 5 treatments with the Fraxel® SR Laser System at 15 mJ and 1500 MTZ/cm^2. MTZ indicates microthermal zone. Photographs courtesy of Zakia Rahman, MD.

DISCUSSION

The present study is the first to report the efficacy and safety of the Fraxel SR Laser System in the treatment of acne, surgical, traumatic, and striae scars. Blinded investigators noted improvement in 91% (43 of 47) of scars at 3 months after the final treatment. Overall scar severity was significantly reduced for all scars, acne scars, and surgical scars as judged by both blinded investigators.

Resolution of edema may depend upon the energy level administered, as it is directly correlated with

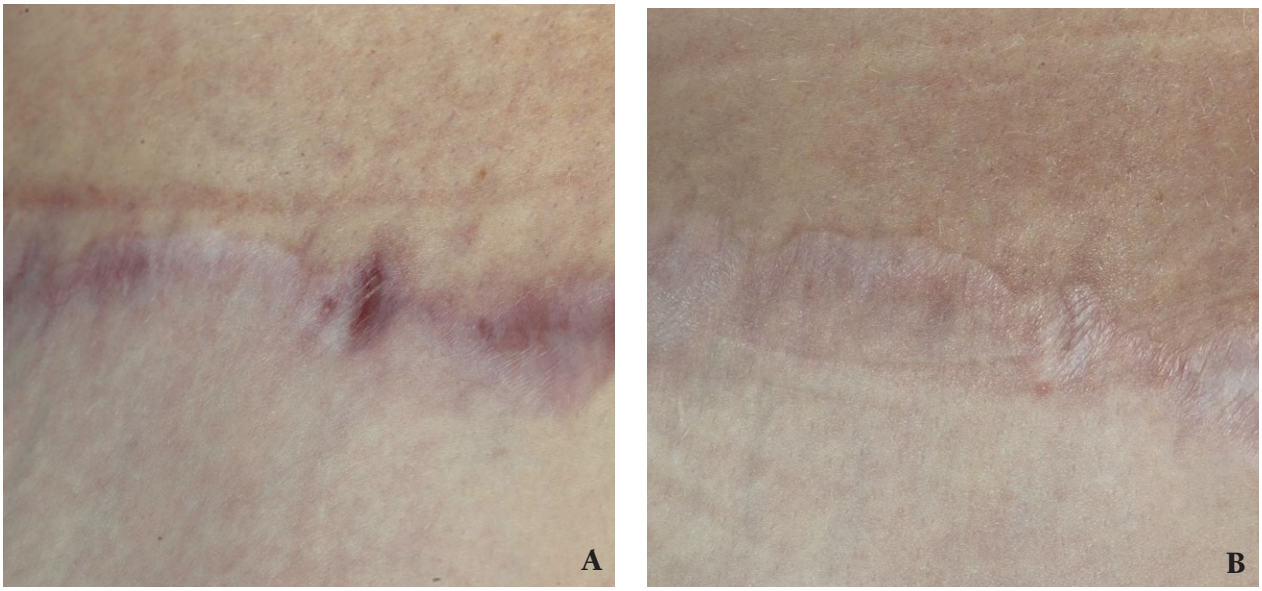

Figure 3. A postabdominoplasty surgical scar on a 56-year-old woman (Fitzpatrick skin type II) before (A) and 3 months after (B) the final of 5 treatments with the Fraxel® SR Laser System at 20 mJ and 1000 MTZ/cm^2. MTZ indicates microthermal zone. Photographs courtesy of Zakia Rahman, MD.

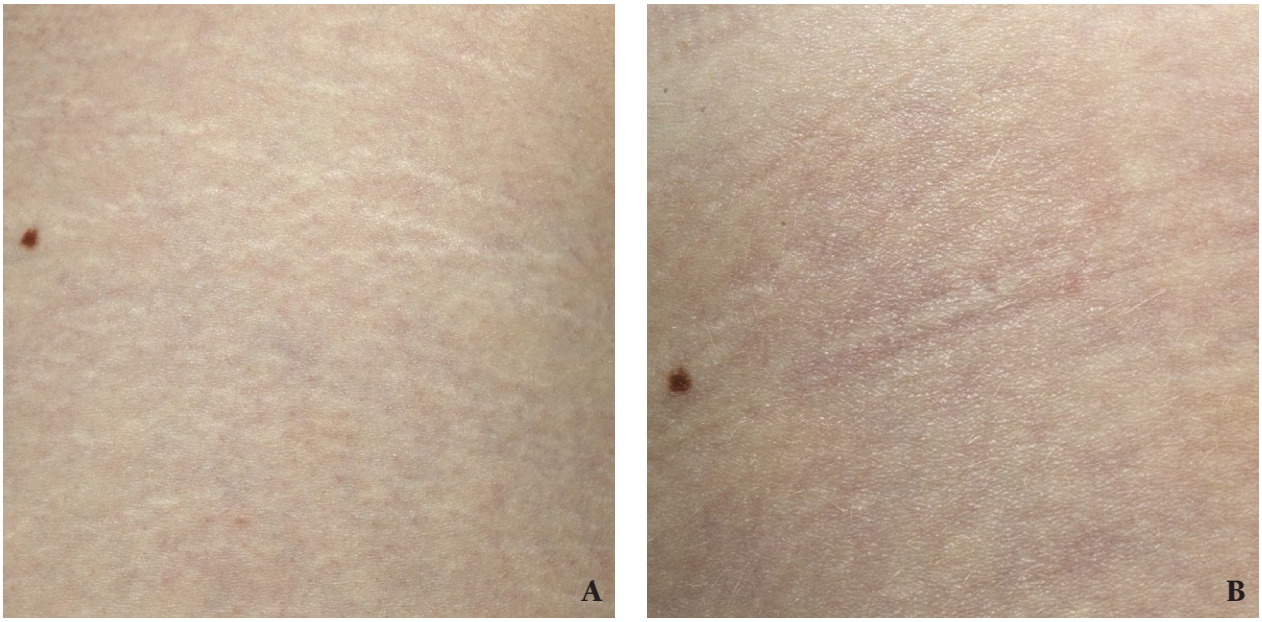

Figure 4. An abdomnial striae scar on a 32-year-old-woman (Fitzpatrick skin type II) before (A) and 3 months after (B) 4 treatments with the Fraxel® SR Laser System at 8 mJ and 3000 MTZ/cm^2. MTZ indicates microthermal zone. Photographs courtesy of Zakia Rahman, MD.

depth of penetration. Duration may range from 1 to 2 days with lower-energy settings and up to 7 days with higher-energy settings. PIH development did not appear to be associated with the number of treatments or treatment parameters. Late-onset PIH was observed only in subjects of skin types II, III, and IV; however, 4 subjects of skin types V and VI were treated without adverse sequelae. Subjects with PIH demonstrated partial to complete resolution through the 3-month follow-up visit, although very slight to slight PIH was still apparent in 9 subjects (Table 5). To limit confounding variables, no concomitant topical bleaching products were utilized. In practice, 4% hydroquinone should be prescribed to ameliorate pigmentary changes as they develop and to expedite resolution of the condition.

The efficacy of FP in the treatment of scars has been reported in many studies,[10,13,16-22] all with encouraging results. Rokhsar and colleagues[13] reported improvement in skin texture, with decreased scar severity in all 10 patients with atrophic acne scars and surgical scars. Four other groups[10,19,20,22] reported improvement in acne scars. Fisher and colleagues[16] reported improvement in the appearance of surgical scars and in acneiform scars.[18] Weinstein and colleagues[17] reported greater than 50% improvement in acne scars in more than 90% of 16 patients.

Pulsed, scanned, or high-energy CO_2 or Er:YAG lasers have been used to treat atrophic scars.[23-28] Modern CO_2 and Er:YAG lasers achieve therapeutic effects by selective photothermolysis,[29] and clinical benefits are attributed to collagen shrinkage and persistent collagen remodeling.[4] Improvements ranging from 50% to 80% have been reported with CO_2 lasers.[25,26,28]

Disadvantages of CO_2 laser treatments include prolonged erythema, long recovery periods,[30,31] and permanent hyperpigmentation.[32] Short-pulsed Er:YAG lasers offer an improved adverse effect profile (due to less thermal damage) but reduced clinical improvement, poor hemostasis during surgery, and limited collagen contraction.[28,33] Long-pulsed Er:YAG lasers offer better clinical results and reduced intraoperative bleeding.[4] Dual-mode (short- and long-pulsed) Er:YAG lasers have been associated only with transient hyperpigmentation and acne flare-ups, no hypopigmentation or scarring, erythema lasting less than 1 month in most patients, and PIH resolving in less than 3 months. Clinical improvements, however, were less than those obtained with CO_2 lasers.[34]

It is difficult to compare the efficacy of the Fraxel SR Laser System with that of CO_2 and Er:YAG lasers because scar improvement in studies of these systems[27,34-37] was evaluated on scales different from the 0-to-9 scale used for the independent evaluations in the present study. Earlier studies also did not report results of the various characteristics of scar severity. However, as has been demonstrated with the ablative devices described previously,[4,25-26] this study confirmed the ability of the Fraxel SR Laser System to deliver significant clinical improvement to scars of a variety of etiologies (Figures 1–4).

As reported earlier, mild erythema occurred in only 17.5% of patients in the present study. Erythema was also

TABLE 5

Posttreatment Responses During Follow-up Period*

Adverse Effect	Subjects Without Adverse Effect, n (%)	Subjects With Adverse Effect, n (%)	Severity Score, Mean±SD†
Erythema			
1 month	35 (87.5)	5 (12.5)	1.10±0.22
3 month	40 (100)	0 (0)	0±0
Edema			
1 month	40 (100)	0 (0)	0±0
3 month	40 (100)	0 (0)	0±0
PIH			
1 month	31 (77.5)	9 (22.5)	0.75±0.27
3 month	31 (77.5)	9 (22.5)	0.67±0.25

*PIH indicates postinflammatory hyperpigmentation.

†Erythema and edema severity scores: 0=none, 1=mild, 2=noticeable, 3=moderate, 4=significant, 5=very significant, 6=severe; PIH severity score: 0=none, 1=mild, 2=moderate, 3=severe.

reported in a previous study of short-term adverse effects of FP.[38] Walia and Alster[27] reported erythema as "typical" in patients treated with the CO_2 laser and lasting an average of 3.5 months. Cho and Kim,[35] who treated atrophic facial acne scars with a high-energy CO_2 laser and Er:YAG laser, reported erythema in 100% of patients, as did Tanzi and Alster[36] in a comparison of the 1450-nm diode laser and 1320-nm Nd:YAG laser.

Persistent posttreatment edema, dry skin, scaling, superficial scratches, pruritus, increased sensitivity, and acneiform eruption were not observed in the present study as in an earlier study of FP.[38] As in this previous study, posttreatment scarring, herpetic activation, hypopigmentation, persistent erythema, and infection were not observed.

CONCLUSION

FP with the Fraxel SR Laser System successfully reduced the severity of acne, surgical, traumatic, and striae scars as assessed by 2 blinded investigators, treated subjects, and the study investigator. Color mismatch, surface texture abnormalities, and atrophy were also improved within each scar type. The treatment was well tolerated, and no adverse events were observed. PIH appearing at different stages of treatment and follow-up was transient and mild and progressed toward resolution during the study, even without concomitant topical therapy. Our results suggest that additional studies to assess long-term benefits are warranted.

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