Comparison of Nonablative Fractional Erbium Laser 1,340 nm and Microneedling for the Treatment of Atrophic Acne Scars: A Randomized Clinical Trial

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BACKGROUND The efficacy and safety of nonablative fractional laser for acne scars treatment has been described in several studies. Recently, microneedling treatment has been showing promising results with lower costs, quick healing time, and low risk of postinflammatory hyperpigmentation (PIH).

OBJECTIVE To compare the effectiveness and safety of nonablative fractional erbium laser 1,340 nm and microneedling for the treatment of facial atrophic acne scars.

METHODS Forty-six patients with atrophic facial acne scars were randomized to microneedling and laser groups, receiving 3 sessions performed monthly. Two blinded dermatologists applied the validated "Quantitative Global Grading System for Postacne Scarring" scale, before, 2 months, and 6 months after the treatment. Side effects were recorded at each follow-up visit and patient's satisfaction was evaluated.

RESULTS Both groups showed a significant improvement, and there was no statistically significant difference between results of both therapies (p = .264). The erythema after each session was longer in the laser group and 13.6% subjects experienced PIH. No PIH was observed in the microneedling group.

CONCLUSION This study shows that both nonablative fractional laser 1,340 nm and microneedling are comparable and effective in the treatment of atrophic acne scars. Microneedling is well tolerated, with fewer side effects and lower down time.

Supported by Etheria/Industra Platform, Dr. Roller, and DermoMax, all of which have provided the devices used in this study.

Acne scars are highly prevalent and have an important impact on the quality of life. In many cases, it presents as a therapeutic challenge for dermatologists.[1–3]

The efficacy and safety of nonablative fractional photothermolysis (NAFP) for the treatment of acne scars have been described in several studies.[4–14] Recently, microneedling technique has shown promising results in the treatment of acne scars, and also low cost, fast recovery, and lower risk of postinflammatory hyperpigmentation (PIH) when compared with other techniques.[1,15] However, to our knowledge, there are no controlled studies comparing both techniques.

The main objective of this study was to compare the effectiveness of nonablative fractional erbium laser 1,340 nm with microneedling technique for the treatment of atrophic acne scars on the face. Additionally, secondary objectives were to assess the degree of satisfaction of patients and to verify the tolerability and the incidence of adverse events with both techniques.

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ISSN: 1076-0512 • Dermatol Surg 2016;42:232–241 • DOI: 10.1097/DSS.0000000000000597

Methods

The authors conducted an evaluator-blinded randomized clinical trial, comparing the application of nonablative fractional erbium ProDeep laser 1,340 nm and the percutaneous collagen induction therapy performed by microneedling technique, respectively, laser group, and microneedling group (MNG).

Patients with the diagnosis of moderate or severe atrophic acne scars were recruited from the Dermatology Outpatient Clinic of Hospital de Clínicas de Porto Alegre, Brazil.

To detect a difference of 1 SD in the score between groups, assuming a power of 90% and an α error ≤ 0.05, a sample of 23 patients for each treatment group was necessary.[16,17]

Exclusion criteria included: personal history of photosensitivity or photosensitive diseases such as systemic lupus erythematosus and xeroderma pigmentosum; history or presence of PIH; use of drugs that induce hyperpigmentation (such as amiodarone, clofazimine, minocycline, and chloroquine); presence of only ice pick acne scars; pregnancy or breastfeeding; oral isotretinoin use in the last 6 months; facial surgical or laser treatment in the last 3 months; herpes infection, warts, or any other active skin infection in the treatment area; presence of skin cancer or actinic keratoses over the treatment area; coagulopathies or anticoagulant therapy; personal history or presence of hypertrophic scars or keloids; patients in chemotherapy, radiation therapy, or with high-dose of corticosteroids; diabetes mellitus; inability to understand the objectives and risks of treatment or patients who refused to participate or to sign the consent form.

Patients considered eligible were invited to participate and to sign an informed consent form. Patients under 18 years signed the informed assent term and their parents or legal guardians signed an informed consent form.

The translated and previously validated for Brazilian Portuguese Quantitative Global Grading System for Postacne Scarring Instrument (QGGSPS)[18,19] was applied to evaluate the degree of scars. This quantitative scale evaluates the type, number, and severity of scars attributing a value that ranges from 0 to 84.[18,19]

A questionnaire with the following information for each participant was completed: sex, age, skin type, profession, current or previous history of smoking, medications, and presence of active acne. All participants were examined and had assessment of the acne scar with the Portuguese version of the QGGSPS scale. The predominant atrophic scar type and their localization were analyzed. After this evaluation, the patients were allocated by simple drawing to one of the study groups (simple randomization). The randomization system was performed using Microsoft Excel.

Patients of both groups were assigned to 3 sessions of laser treatment or 3 sessions of treatment with microneedling, performed monthly by the same dermatologist. The same treatment parameters were used for each subject from both groups. The clinical endpoint was the improvement of the degree of acne scars using the validated "Quantitative Global Grading System for Postacne Scarring" scale.

Topical anesthetic (lidocaine cream 4%—Dermomax/Aché) was applied on the face 30 minutes before each treatment session of both groups (microneedling and laser). Immediately before each session, the anesthetic was removed and the skin was cleansed with aqueous 2% chlorhexidine solution. In each laser session, nonablative fractional erbium laser ProDeep 1,340 nm (Etheria/Industra platform) was performed with a 100 microbeams per cm^2 in the whole face, followed by a second pass in the areas with the highest concentration of scars. The instrument was calibrated to use energy of 120 mJ per microbeam and 5-millisecond pulse duration. The parameters used in the laser sessions were equivalent to those used in previous studies using 1,550 and 1,450 nm, and were calculated so that it would be possible to reach a treatment coverage of 20% to 35%.[6,9]

Microneedling sessions were performed using a device containing 192 fine microneedles of 2 mm (Dr. Roller/MTO Importer and Distributor). Approximately 20 passes in 4 different directions were applied to the

face.[20,21] After the procedure, the skin was cleaned with saline-soaked gauze. The microneedling device was discarded after each session; therefore, a new instrument was used in the each sitting. After each laser and microneedling session, participants were instructed to avoid sun exposure and use sunscreen of at least SPF 30.

Two independent and blinded dermatologists applied the validated "Quantitative Global Grading System for Postacne Scarring" scale, before, 2 months, and 6 months after treatment. Six months after the end of treatment, patients completed a questionnaire that assessed their perception of the degree of improvement of their scars, and also pain during treatment and recovery time. The values were assigned from 0 to 10, where 0 meant the maximum of dissatisfaction and 10 meant the maximum satisfaction.

Statistical Analysis

To assess the concordance between evaluators, the authors compared their measurements by Student *t*-test for paired samples and the intraclass correlation coefficient. The generalized estimating equation (GEE) was used to assess the difference in the degree of scarring (with the score established by the scale) before and after treatment and to compare the degree of pain. Posttreatment erythema was compared by the Mann–Whitney test.

The χ^2 test was used for the evaluation of other symptoms, such as crusts, blistering, pustules, or edema, and for the perception of improvement after each session. The degree of improvement perceived by the patients was compared between both groups using the Student *t*-test.

Data were processed using IBM SPSS 18.0 version software for statistical analysis and a 5% significance level was considered.

Ethical Considerations

The project was approved by the institutional Ethics Committee and all participants signed the informed consent. This study received financial support from the HCPA Research Fund (FIPE) and Capes. Materials (dermaroller) and equipment (Etherea laser) were donated by MTO Importadora e Distribuidora Industrie and Industra Industrie, respectively, for unrestricted use.

Results

Forty-two participants completed the treatment sessions and the follow-up period. Of these, 21 were females and 21 males, with ages between 16 and 50 years (mean age: 26.33 years). Twenty patients received the microneedling treatment and 22 patients received the laser treatment (Table 1).

A total of 21 patients had predominantly boxcar type scars (48.8%), 18 (41.9%) had mainly the rolling type scars, and 3 (7%) had mostly ice pick scars. There was no difference between groups regarding sex, age, skin type, presence of active acne, predominant atrophic scar, smoking, and the use of medications.

The Student *t*-test for paired samples showed $t_{gl} = -0.675$: $p = .503$ in the first evaluation and $t_{gl} = 1.309$: $p = .198$ at posttreatment evaluation. This demonstrates a high agreement between interobserver values, which confirms the applicability and power of scale, and the legitimacy of the score of each patient. The intraclass correlation coefficient for intraobservers was 0.94 for the first evaluation and 0.97 for the posttreatment evaluation.

Both groups showed a significant clinical and statistical improvement of the degree of acne scars (Figures 1 and 2). The initial average score on the scale in MNG was 14.9 (SE = 0.97) and became 10.85 (SE = 1.0) after treatment. In the laser group, the initial score was 15.82 (SE = 0.86) and reached 12.41 (SE = 0.77). Thus, there was an improvement of 4.05 points in the MNG and 3.41 points in the laser group (Figure 3). This improvement was significant, since a difference of 3 to 5 points on the scale represents a clinically significant difference (according to information provided by the author of the scale). Also, according to the GEE, the differences obtained also were statistically significant ($p < .001$), regardless of the type of treatment. However, since both final treatment groups had a substantial improvement, there was no statistically

TABLE 1. Baseline Characteristics of Patients With Acne Scars Treated With Laser or Microneedling

Characteristic	*Group 0 (Microneedling), n = 20*	*Group 1 (Laser), n = 22*	*p*
Age	27.35 (EP = 10.72)	25.41 (SE = 8.77)	.523
Female, n (%)	10 (50)	11 (50)	1
Phototype, n (%)			.4
II	1 (5)	0 (0)	
III	14 (70)	15 (68.2)	
IV	5 (25)	5 (27)	
V	0 (0)	2 (9.1)	
Anatomical location, n (%)			
Cheeks	18 (90)	22 (100)	.221
Chin	4 (20)	3 (13.6)	.691
Forehead	6 (30)	7 (31.8)	1
Temporal region	17 (85)	15 (68.2)	.284
Nasal region	0 (0)	2 (9.1)	.489
Type of scar			.775
Boxcar	11 (55)	10 (45.5)	
Rolling	8 (40)	10 (45.5)	
Ice pick	1 (5)	2 (9.1)	
Active acne	6 (30)	6 (27.3)	1

SE, standard error.

significant difference between results of both therapies (p = .264).

Patients with mostly *boxcar* type scars had an average decrease of 4.095 points on the scale (±2.32; SE = 0.506). In patients with predominantly *rolling* scars, the mean decrease was 3.72 points (±1.27; SE = 0.3), and when the most common scar was the *ice pick* type, the mean decrease was 1 point (SE = 0).

There was no significant difference in the degree of pain during treatment between the groups, with an average of 5.72 (SE = 0.4) in the MNG and 6.18 (SE = 0.4) in the laser group (p = .416).

Figure 1. Pretreatment and posttreatment photographs of a microneedling group participant.

Figure 2. Pretreatment and posttreatment photographs of a laser group participant.

The posttreatment erythema was longer in the laser group, with a median of 3 days after the first and second sessions and 2 days after the third session. In the MNG, the median was one day of erythema after each of the 3 sessions. However, both treatments were well tolerated and recovery time was limited to the day of the session. Overall, patients denied having to miss work or daily activities after the sessions.

Regarding the risk of PIH, each treatment group had 5 patients with skin type IV, whereas patients with skin type V were only found in the laser group. Although there was a difference in the number of patients skin type V, PIH was only observed in 2 participants skin type IV, which were in the laser group. No patients in the MNG developed PIH. The frequency of the other adverse events can be seen in Table 2.

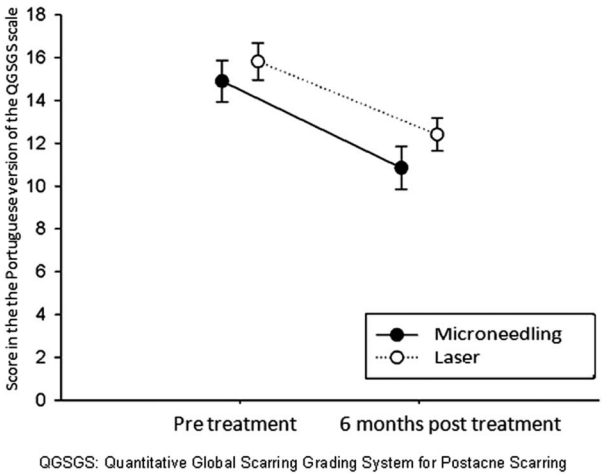

Figure 3. Improvement scores of acne scars with both treatments.

A total of 65% of microneedling patients and 86.4% of the laser patients perceived an improvement after the first treatment session. Furthermore, 100% of participants in both groups noted improvement after the second session. The degree of improvement after the full treatment, perceived by the patients, rated on a scale from 0 to 10, had an average of 7.65 (±1.92; SE = 0.43) in the MNG and 7.95 (±1.17; SE = 0.25) in the laser group. The difference between the groups was not statically significant (p = .536).

Discussion

Scars are the main complication of acne and their treatment is a challenge for dermatologists. Acne scars cause impairment of quality of life and have been described as a risk factor for suicide. Furthermore, it has also been linked to poor self-esteem, depression, anxiety, and lowered academic performance.[2,3] Although they can affect up to 95% of patients with acne, prevalence data of acne scarring are variable in studies.[22,23]

Regarding acne scar types, the atrophic forms are the most common, accounting for 80% to 90% of cases.[1]

TABLE 2. Complications of Treatment of Acne Scars With Laser and Microneedling

Complications	*Microneedling Group (n = 20), n (%)*	*Laser Group (n = 20), n (%)*	*p*
Crusts	7 (35)	8 (36.4)	1.0
Pustules	1 (5)	1 (4.5)	1.0
Bullae	0 (0)	5 (22.7)	.049
Pain after session (≥2 h)	1 (5)	3 (13.6)	.290
PIH	0 (0)	3 (13.6)	.233

Many treatments have been proposed, most showing unsatisfactory results or high levels of complications.[7] The development of fractional photothermolysis (FP) technology, since 2003, deeply changed the laser treatment of atrophic acne scars. Although the first ablative and nonablative technologies produced layers of thermal damage, FP causes thermal columns. Therefore, in FP, the tissue damage occurs in microscopic dermal columns, not restricted to a specific target. Because each microscopic thermal zone is surrounded by viable tissue, keratinocytes have a smaller migration path, turning the healing process faster. Within the fractional technology, nonablative lasers have the advantage of generating selective damage to the dermis while protecting the epidermis, which further reduces recovery time and adverse events.[24]

Nonablative fractional photothermolysis is gaining more space in the treatment of acne scars among dermatologists because of its shorter recovery time, convenience for patients, and, consequently, higher compliance to treatment.[20] Ong and Bashir[12] conducted a review of fractional laser resurfacing for acne scars and found slightly better results of fractional ablative photothermolysis, when compared with NAFP. However, the authors observed that most of the studies only examined one type of laser device.[12] Regarding the few studies that made comparisons between treatment modalities, the rating scales were subjective and differed widely across studies. Also, none of the methods used for assessing clinical outcome had been investigated for validity or reliability.

Another method of treatment, the recently developed microneedling technique, seems to show good results. Besides the advantage of causing fewer side effects, it is inexpensive, shows a rapid healing, and allows the treatment of areas difficult to reach.[1,15] Because both treatments demonstrate positive clinical results and a low rate of complications, they have gained an important role in the treatment of acne scars.

Regarding the treatment modalities and their ability to penetrate the skin, it is estimated that the skin's surface thickness is approximately 196 micrometers, since it is the sum of the epidermis (105 μm), papillary dermis (105 mM), and reticular dermis (1,986 μM). Sardana and colleagues[14] examined the correlation between the depth and energy of several fractional lasers and found that for the laser 1,550 nm (the most similar to the laser used in this study), for each mJ, the depth of coagulation increased approximately by a factor of 10 μm (10 mJ/100–150 μm.) Therefore, with a dose of 100 mJ, a 1,000-μM depth can be reached.[14] Likewise, in the microneedling procedure, the needles reach a depth of 1.5 to 2 mm, creating multiple microlesions in the papillary dermis, which stimulates the cascade of growth factors, neocollagenesis, and neoangiogenesis.[17] The depth of neocollagenesis was found to be an average of 5 to 600 μM using 1.5-mm length needles.[15]

The decision to use the parameters for the microneedling technique in this study was based on the most recent and largest studies published using this instrument for the management of acne scars.[17,25] However, it is known that the number of treatments required with NAFP and microneedling varies depending on the individual collagen response, the condition of the tissue, and the desired results.[1] In this study, the authors chose to perform 3 treatment sessions with 1 month interval, since a previous study with microneedling has shown that most patients require around 3 treatments, approximately 4 weeks apart.[1] However, it is not established if more number of sessions could result in still higher efficacy.[25] Regarding nonablative fractional laser, studies have recommended

2 to 6 sessions to achieve good results.[20] Also, further improvements in scar texture with both techniques may have been found if the follow-up period had been extended beyond 6 months, since collagen remodeling can occur up to 12 months.[9]

Several studies have demonstrated the efficacy of NAFP for the treatment of acne scars, as can be seen in Table 3, which summarizes the results of the main studies. However, there are fewer studies evaluating the effectiveness of microneedling technique. Niwat[15] showed a 50% improvement in acne scars in 67.74% of 31 patients who underwent microneedling. Moreover, in a study of 36 patients treated with microneedling, 34 achieved a significant reduction in the degree of acne scars.[21] In 2014, Dogra and colleagues[25] performed 5 monthly sessions microneedling in 30 subjects with acne scars and skin types IV and V. There was significant improvement of the scars, based on the photograph evaluation and a quantitative scale. Five participants developed PIH, which was mild and resolved spontaneously in 2 patients.[25]

A recent study with 39 patients treated for acne scars compared the efficacy of sessions of microneedling associated with trichloroacetic acid 20%, 1,540-nm nonablative fractional laser, or the association of both treatment modalities with alternating sessions. The authors found that patients who underwent combined treatment with alternating sessions showed better clinical response than those who received only one treatment modality, suggesting that when both techniques are associated the results are superior.[26]

The aim of this study was to compare the effectiveness of the 2 techniques and the degree of satisfaction of patients, and also their tolerability and incidence of complications.

In this present clinical trial, there was significant improvement of acne scars with both techniques (microneedling and NAFP). The positive clinical response with both treatments ratifies literature data and previous studies. However, the demonstration that both techniques show comparable results is new information that can be very useful in the dermatological daily practice.

The wide range of scales used to assess improvement of acne scars in studies with laser and microneedling hinders an accurate assessment of the effectiveness of these procedures and the comparison between them. Therefore, the use of a validated scale that defines a severity score can help standardize studies and contributes to more accurate and comparable results.[14] Moreover, most studies examine only one type of treatment, whereas comparisons between 2 treatment techniques are rare.[12]

Presently, there is an increasing demand for effective treatments, however with a fast healing time and a minimal requirement of absence of work and daily activities. The 2 treatments compared in this study show this advantage. The microneedling presents an additional advantage regarding its low cost and ease of access by dermatologists. In this study, microneedling demonstrated a better adverse events profile compared with laser treatment (Table 2).

In the laser group, the onset of the clinical response appeared before, with 86.4% of patients perceiving an improvement after the first session, compared with 65% of MNG. However, after the second session, 100% of participants in both groups noticed improvement. Since several sessions are recommended to reach a satisfactory result for both treatments, this observation may be important only for patients seeking more immediate results.

It is assumed that patients with more boxcar and rolling type scars had a greater degree of improvement than those with mainly ice pick scar type ($p = .028$ and .062, respectively); however, we can not confirm such statement because of the small sample of patients with predominantly ice pick scars. Furthermore, this tendency of lower clinical response of ice pick scars found in our study corroborates results of previous studies.[14,24]

The results of our study reinforce the efficacy and safety of NAFB treatment of atrophic acne scars, as already established by previous studies. Furthermore, in addition of confirming the efficacy of microneedling, it was demonstrated that this technique induces comparable clinical results.

TABLE 3. Literature Review on Nonablative Fractional Photothermolysis

No	*Study*	*Number of Participants*	*Phototype*	*Study Draw*	*Results*
1	Alster and colleagues[5]	53 (39 F, 14 M)	I–V	Monthly sessions with 1,550-nm erbium-doped laser	Improvement of acne scars from 51% to 75% in 90% of the participants
				Final evaluation 6 mo after treatment	No pigmentary disorders or generation of scar
2	Chrastil and colleagues[6]	29 (20 F, 9 M)	I–V	2–6 monthly sessions with 1,550-nm erbium-doped laser	Improvement of acne scars: 50% to 75% in 18 patients
				Final evaluation 1 mo after treatment	>75% in 5 patients/from 25% to 50% in 5 patients
					<25% in 1 patient
					No pigmentary disorders or generation of scar
3	Cho and colleagues[8]	12 (5 F, 7 M)	IV	3 monthly sessions with 1,550-nm erbium-glass laser	Improvement of acne scars: 51% to 75% in 5 patients
				Final evaluation 4 mo after treatment	76% to 100% in 3 patients
					26% to 50% in 2 patients
					2 patients: minimal or absent improvement
					No pigmentary disorders or generation of scar
4	Hasegawa and colleagues[4] (2006)	10 (7 F, 3 M)	Uninformed	1–3 sessions with *erbium glass* 1,550 nm, at intervals of 2–3 wk between them	7 patients: good or excellent improvement
					3 patients: moderate improvement
					No pigmentary disorders or generation of scar
5	Hu and colleagues[7]	45	III–IV	1 session with 1,550-nm erbium-doped laser	49.9%: good to excellent improvement/51.1% minimal improvement
				Final evaluation 4 mo after treatment	Ephemeral adverse effects: average duration of 6–7 d for erythema, edema, 2–4 d, 5–7 d hyperpigmentation; acneiform eruption 4–6 d
6	Badawi and colleagues[10]	22	III–IV	Nonablative fractional laser 1,064 nm (average of 6 sessions per patient)	For analysis, 4-point scale was used: 0 ≤25% of improvement
					1 = 25% to 50%, 2 = 51% to 75%, and 3 = 76% to 100%
					Significative improvement of scars (2), marl texture (2.3), and PHI
					No pigmentary disorders or generation of scar

TABLE 3. (Continued)

No	Study	Number of Participants	Phototype	Study Draw	Results
7	Hedelund and colleagues[9]	10 (6 F, 4 M)	I–III	First randomized clinical trial to evaluate the NAFP in treatment of acne scars	Scars became significantly more uniform and mild
				3 monthly sessions in a hemiface of each patient with nonablative fractional laser 1,540 nm	Patients expressed satisfaction with the outcome
				The contralateral hemiface was untreated	No pigmentary disorders or generation of scar
				Final evaluation 3 mo after treatment	
8	Bencicni and colleagues[13]	87 (51 F, 36 M)	Uninformed	6 sessions with laser erbium glass 1,540-nm (intervals of 3 wk between sessions)	7/87 (8%): moderate improvement
				Final evaluation 6 mo after treatment	80/87 (92%): significative improvement
					4/87 (5%)mild acneiform eruption (controlled with topical clindamycin)
					1/87 patients (phototype V) developed mild hyperpigmentation with spontaneous resolution in a month
9	Sardana and colleagues[14]	35 (17 F, 18 M)	Uninformed	6 sessions with laser erbium glass 1,540-nm (intervals of 3 wk between sessions)	Boxcar: 52.9%/rolling: 43.1%/ ice pick: 25.9% of improvement
				Final evaluation 6 mo after treatment	16.7% (n = 5): good improvement (from 51% to 75%)
					46.7% (n = 14): moderate improvement (from 25% to 50%)
					36.7% (n = 11): mild improvement (<25%)
					40% (n = 12): transient PIH (resolution in 8.5 d on average)
					86.7% (n = 26) transient acneiform eruption (resolution in 5.38 d on average)

Conclusion

This evaluator-blinded randomized clinical trial proves that both the nonablative fractional laser and the microneedling are comparable and effective in the treatment of acne scars. The evaluation performed by a validated scale allows future comparisons with other acne scars' treatment techniques, and also the reliability of results.

Participants from both groups perceived clinical improvement, which was not statistically different

between groups. Both treatments were also well tolerated and did not significantly affect patients' daily activities. However, the microneedling technique showed a better complication profile compared to nonablative fractional laser.

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