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Monopolar radiofrequency versus pulsed dye laser for treatment of acne scars: a randomized clinical trial

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Abstract

Introduction. The main aim of the current study was to compare the effect of monopolar radiofrequency (MRF) and pulsed dye laser (PDL) in reducing acne scars and improving the cosmetic appearance.
Methods. Overall, 30 patients suffering from mild or severe acne scars evaluated with the *échelle d'évaluation clinique des cicatrices d'acné* (ECCA) grading scale were randomly distributed into 2 groups. Group A (MRF group) was subjected to 1 session (8 minutes for each cheek) per month of MRF for 4 months. Group B (PDL group) received 1 session (5 minutes for each cheek) per month of PDL for 4 months. Pre- and post-treatment acne scar severity was assessed by using the ECCA grading scale and the self-assessment of clinical acne-related scars (SCARS) scale. Quality of life and the emotional impact of acne scars were evaluated by the facial acne scar quality of life (FASQoL) scale.
Results. Both groups presented a significant decrease in ECCA scale, SCARS scale, and FASQoL scale after the treatment compared with the pre-treatment status ($p < 0.001$). There was a significant reduction in scores of ECCA scale, SCARS scale, and FASQoL scale in group B compared with group A after the treatment ($p < 0.001$).
Conclusions. PDL is highly more effective than MRF in patients with acne scars.
Key words: acne scars, monopolar radiofrequency, pulsed dye laser

Introduction

Acne is a common skin disorder, with an incidence of about 85% among adolescents [1]. There are different skin lesion types, including erythematous pustules and papules, black and white comedones, multiple nodules and deep pustules in untreated severe cases, and scarring in untreated cases. The most commonly affected sites are face, neck, the upper part of the chest and the back [2].

Atrophic acne scarring is caused by impaired resolving or healing of lesions due to sebaceous gland follicles during the inflammatory phase [3]. Scars are generally categorized by depth and shape into rolling, icepick, and boxcar scars [4], which often impair deeper layers, causing atrophy. Additionally, tissues are destroyed by enzyme activities and by inflammatory mediators released from disrupted follicles and cysts of acne [5].

Radiofrequency devices are considered an effective option to reduce scars by collagen remodelling stimulation. There is one point of contact for the original site of the electrical current in the monopolar radiofrequency (MRF) device. The current is reduced as it passes to a far grounding pad [6]. As radiofrequency current passes through the skin, the generation of heat is proportional to the tissue impedance [7]. It also causes skin tightening by stimulation of neocollagenesis, which is a secondary outcome in patients with skin laxity [8], and leads to thickening of the dermis and increasing the skin tone [9].

Pulsed dye laser (PDL) is used as a potential option to treat acne scars, as the light with different wavelengths, like those in the sunlight, may improve the appearance of acne scars [10]. Light wavelengths emitted by PDL are absorbed by the oxygenated haemoglobin, and energy densities with high irradiation are applied for vascular lesion treatment; these high fluences cause ablation of small blood vessels and bleeding to the subcutaneous tissue [11]. Non-ablative fluences with lower frequencies have no purpuric effect; however, the treatment increases the production of collagen, leading to an improvement in wrinkle and acne scarring appearance [12].

Previous studies have investigated the effect of MRF and different types of laser, such as PDL and Nd:YAG laser, on acne scars. Nevertheless, there has been no study comparing the effect of MRF and PDL. So, this study was carried out to determine which modality (MRF or PDL) had a greater effect in patients suffering from acne scars.

Subjects and methods

Study design

A single-blind randomized clinical trial was carried out between January 2019 and July 2020. The sample size was calculated for the *échelle d'évaluation clinique des cicatrices d'acné* (ECCA) scale (clinical evaluation scale for acne scarring), as a primary outcome measure, by using the G*Power 3.1 program, with the effect size of 0.291, α errors of 0.05, and power of 80%. The estimated required total sample size was 30 patients.

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Patient characteristics

A total of 30 patients (12 males and 18 females) having acne scars were randomly selected from students of Faculty of Physical Therapy, Cairo University to participate in this study. The patients met the set selection criteria: age of 19–23 years and the presence of unresponsive to medical treatment mild to severe acne scars in the face (both cheeks). The exclusion criteria involved smoking and alcohol consumption, history of diabetes, circulatory or sensory disorders, history of frequent sunburns, and nodulocystic acne.

The participants were randomly distributed into 2 groups (15 individuals per group) by an independent care provider who opened closed envelopes, each including a computer-generated randomization card. Group A (MRF group) was subjected to 1 session of MRF therapy per month for 4 months, while group B (PDL group) received 1 session of PDL per month for 4 months. All patients were assessed carefully by a dermatologist and were informed of the study procedures before enrolment. They did not receive any other treatment that might affect the results of the study. All participants were under the same medical condition and situation.

Procedures

Assessments

All patients were assessed by using the ECCA scale, the self-assessment of clinical acne-related scars (SCARS) scale, and the facial acne scar quality of life (FASQoL) scale before the beginning of the treatment and after 4 months of treatment.

Primary outcomes:

– ECCA. It is a grading scale used by dermatologists to evaluate acne scar severity and to investigate the effect of treatment modalities on scars. It is composed of 6 items related to 6 acne scar types [13]. The result is formed of a numerical score reflecting the number of scars (0–4) multiplied by a clinical severity weighting factor (15–50); the total possible score is 0–540 [14].

– SCARS. At recruitment and after 4 months, the patients completed a self-assessment questionnaire (using a scale of 0–10). It consists of 5 items with 1 potential domain that asks patients to determine acne scar severity by self-evaluation in front of a mirror. In order to inform the patient how to distinguish between active acne and acne scars, the evaluation begins with 2 visual analogue scales [15]. All participants understood the scale as they had a good knowledge of the English language.

Secondary outcome:

– FASQoL. This is a 10-item assessment tool with 3 domains for evaluating the emotional, social, and work/school-related effect of scars. The rating scale consists of 5 points [15]. All participants understood the scale as they had a good knowledge of the English language.

Interventions

– MRF therapy. An MRF device (LVT-250; Sometech Inc., Seoul, Korea) was used with the following parameters: 50/60 Hz, radiofrequency output of 470 kHz, 10–20 J/cm^2, 20 mm electrode size [16]. Before MRF application, the treated area was cleaned with gauze with 70% alcohol. Each cheek was treated for 8 minutes with maintenance of the skin temperature of 40–42°C [17].

– PDL therapy. A PDL device (SPTL-1; Candela Corp., Marlborough, MA, USA) was used with the following parameters: 585 nm wavelength, 450 ms pulse duration, 6.0–7.0 J/cm^2 energy density, 7 mm spot size. Each cheek was treated for 5 minutes. No regimens or topical anaesthetics were given before treatment [18].

Statistical analyses

The *t*-test was carried out for age comparison between the groups. Categorical results were compared with the chi-squared test. Before data analysis, the Shapiro-Wilk test was conducted for data normality assessment. Levene's test was applied to evaluate variance equality. Mixed MANOVA was performed to compare within- and between-group effects concerning the ECCA scale, SCARS scale, and FASQoL scale. The Bonferroni correction was used with a post-hoc test for multiple comparisons. The assumed significance level was $p < 0.05$. The SPSS software (IBM, Chicago, USA) version 22 was applied for statistical analyses.

Ethical approval

The research related to human use has complied with all the relevant national regulations and institutional policies, has followed the tenets of the Declaration of Helsinki, and has been approved by the Ethical Committee of Faculty of Physical Therapy, Cairo University, Egypt (No.: P.T.REC/012/002410).

Informed consent

Informed consent has been obtained from all individuals included in this study.

Results

Overall, 37 individuals were selected and assessed for eligibility, 7 patients were excluded as 3 had nodulocystic acne and 4 had a history of frequent sunburns. The remaining 30 participants completed the treatment sessions (Figure 1).

Patient characteristics

Table 1 presents the subject characteristics of groups A and B. No significant difference was noted between the groups in the mean age, sex, or type of scars.

Mixed MANOVA detected that there was a significant interaction of treatment and time ($F = 4.12$, $p = 0.01$). A significant main time effect was observed ($F = 103.36$, $p = 0.001$), as well as a significant main treatment effect ($F = 3.42$, $p = 0.03$).

Table 1. Subject characteristics of groups A and B

Characteristics	Group A	Group B	*p*
Age (mean ± *SD*), years	20.13 ± 1.35	20.26 ± 1.43	0.79
Sex, *n* (%) Males Females	 7 (47%) 8 (53%)	 5 (33%) 10 (67%)	0.45
Type of scars, *n* (%) U-shaped V-shaped M-shaped Hypertrophic Keloid	 3 (20%) 4 (27%) 5 (33%) 2 (13%) 1 (7%)	 3 (20%) 3 (20%) 4 (27%) 3 (20%) 2 (13%)	0.94

Effect of treatment on the ECCA, SCARS, and FASQoL scales

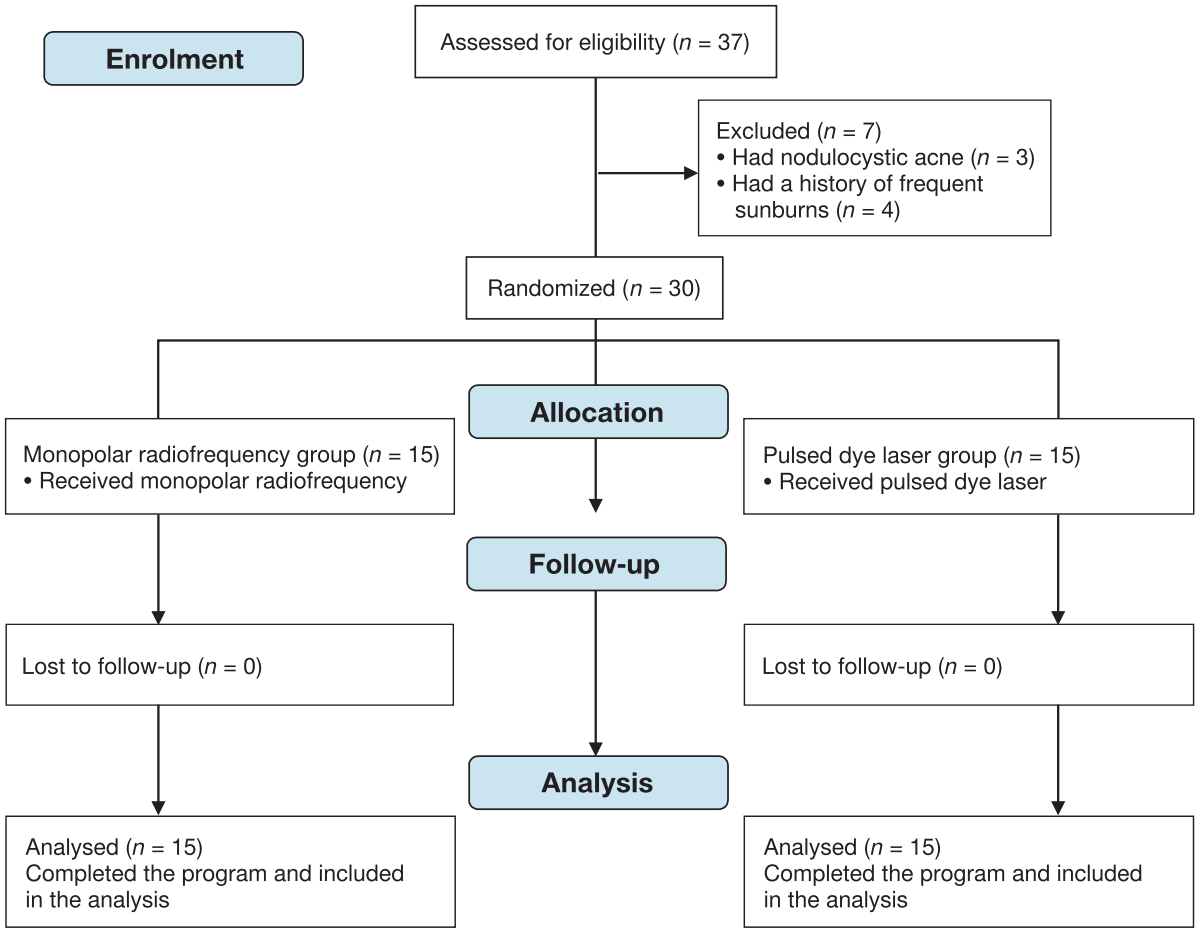

Figure 1. CONSORT flowchart of the study

Table 2. Mean pre- and post-treatment ECCA, SCARS, and FASQoL scores in groups A and B

Characteristics	Group A Mean ± *SD*	Group B Mean ± *SD*	MD (95% CI)	*p*
ECCA scale				
Before treatment	55.66 ± 16.13	57 ± 18	–1.34 (–14.08; 11.41)	0.83
After treatment	30.33 ± 6.11	16.66 ± 4.5	13.67 (9.65; 17.68)	0.001
MD (95% CI)	25.33 (16.91; 33.75)	40.34 (31.91; 48.75)		
	$p = 0.001$*	$p = 0.001$*		
SCARS scale				
Before treatment	14.66 ± 3.3	14.2 ± 3.94	0.46 (–2.25; 3.19)	0.72
After treatment	9.06 ± 1.66	5.2 ± 1.14	3.86 (2.79; 4.93)	0.001
MD (95% CI)	5.6 (4; 7.2)	9 (7.4; 10.6)		
	$p = 0.001$*	$p = 0.001$*		
FASQoL scale				
Before treatment	28.13 ± 3.81	27 ± 7.13	1.13 (–3.14; 5.41)	0.59
After treatment	14.26 ± 3.41	7.53 ± 2.85	6.73 (4.38; 9.08)	0.001
MD (95% CI)	13.87 (10.61; 17.11)	19.47 (16.21; 22.71)		
	$p = 0.001$*	$p = 0.001$*		

ECCA – *échelle d'évaluation clinique des cicatrices d'acné* (clinical evaluation scale for acne scarring)
SCARS – self-assessment of clinical acne-related scars, FASQoL – facial acne scar quality of life, MD – mean difference
* statistically significant values

Within-group comparison

There was a significant decrease in the ECCA, SCARS, and FASQoL scores after the treatment in both groups compared with the pre-treatment status ($p < 0.001$). The reduction in ECCA, SCARS, and FASQoL scores equalled 45.5%, 38.2%, and 49.3%, respectively, in group A and 70.77%, 63.38%, and 72.11%, respectively, in group B.

Between-group comparison

No significant difference was recorded between the groups before the treatment ($p > 0.05$). There was a significant decrease in ECCA, SCARS, and FASQoL scores after the treatment in group B compared with group A ($p < 0.001$) (Table 2).

Side effects of treatment

The post-treatment assessment of the treated area revealed slight erythema in 5 patients in group A and in 7 patients in group B. The distribution of erythema was 33.33% in group A and 46.66% in group B. It was reported that erythema rapidly disappeared within 1 hour after the therapeutic session in both groups. No other side effects were recorded.

Discussion

Acne scars result from the wound healing process, as many cellular and hormonal processes act synchronously. These changes determine the scar size, colour, and texture. Most acne treatments are related to inflammatory acne vulgaris and acne scars; however, persistent erythema may occur in patients with acne after reducing the acute inflammation by treatment [19].

Our study compared the effect of MRF with that of PDL in the treatment of acne scars. Both groups showed a significant decrease in the ECCA, SCARS, and FASQoL scales after the treatment compared with the pre-treatment status ($p < 0.001$). The reduction in ECCA, SCARS, and FASQoL scores was greater in group B (PDL group) than in group A (MRF group).

Ruiz-Esparza and Gomez [20] conducted a study among 22 patients suffering from moderate to severe scars. The response to non-ablative radiofrequency varied: 82% participants presented an excellent response, 9% had a moderate response, while in 9% no response was observed. No side effects were recorded after the procedure. The authors believed that non-ablative radiofrequency produced heat into the dermis and the subcutaneous tissue, causing tightening of the skin.

Ramesh et al. [16] assessed the effect of radiofrequency in 30 adolescents with acne scars in a prospective randomized study. Excellent cosmetic results were reported in 4 patients, moderate in 8 patients, and good in 18 patients. Radiofrequency technology turned out to be a safe, economically viable, and effective modality for acne scar treatment and stimulation of skin resurfacing.

Iyer et al. [21] investigated the effect of radiofrequency in 40 patients with acne scarring of the lower full face, jaws, checks, and anterior neck. The treatment was associated with moderate tolerable pain and mild erythema. Acne scars significantly improved with subsequent treatments for up to 3 months. Superficial blisters were visible in 3 participants and healed with no scarring. The patients' satisfaction increased after treatment.

Alster and McMeekin [18] performed a study among 22 patients to evaluate the effect of PDL (585 nm, 6.5 J/cm^2 average fluence with 7 mm spot size) on acne scars. They reported an improvement in the scar texture by 72.5%. After the treatment, the scars appeared flatter and returned to normal skin surface appearance without side effects.

Patel and Clement [12] evaluated the impact of non-ablative PDL (585 nm) in the elimination of acne scarring. A prospective trial was conducted with 10 patients with deep acne scars in the face, who received PDL sessions for both cheeks. The results showed a visible cosmetic improvement in all subjects, which was caused by the stimulation of collagen deposition in the dermis. The depth of acne scars decreased by 47.8% after the laser treatment. No side effects were reported. PDL proved to be an effective alternative non-invasive modality for reducing acne scars.

Lee et al. [22] compared the efficacy of both PDL (585 nm) and Nd:YAG laser in patients with acne scars. They reported that ECCA scores were reduced significantly, with a significant increase in the deposition of collagen after treatment with both types of laser. There was a thinning of the epidermis in the untreated acne scars and a reduction in the elastic fibre content. The authors concluded that both types of laser were effective methods to improve acne scars.

Alster and Zaulyanov [23] investigated the effect of different laser types on improving acne scars as examined by numerous studies. In this study, the laser used for scar treatment was 585-nm PDL. The results revealed an improvement by 50% in the cosmetic appearance of scars after the PDL treatment. PDL turned out the best choice of laser to treat hypertrophic scars.

The superior influence of PDL may come from its effect on collagen turnover that results from a local increase in mast cell population and the release of histamine, which stimulates normal growth of fibroblasts [24]. Also, PDL increases TGF-β1mRNA levels 5 times after 24 hours, which plays an important role in stimulating collagen production for the reorganization of the dermis [25]. Moreover, the irradiation of blood vessels produces sufficient heat to the dermis to cause changes to the fibrotic collagen within the scar. In addition, significant ischemia results from microvascular destruction, which may stimulate collagenase release [18]. In turn, the mechanism by which radiofrequency improves the appearance of acne scars is only its ability to provide heat through the dermal region and deep layer of the subcutaneous tissue, which stimulates new collagen production [26].

Limitations

This study was limited by the following factors: absence of long-term follow-up after the treatment, differences in the area and severity of acne lesions among the patients, patient variability in the reaction effects on the rate of recovery, and patients' psychological condition that might affect treatment.

Recommendations

Additional studies should be undertaken with other assessment methods, such as histological analyses, ultrasound, and skin surface texture. Also, further studies should be conducted to detect the long-term effect of both modalities.

Conclusions

Both MRF and PDL have a short-term effect on the reduction of acne scars. However, PDL is more effective in improv-

ing the appearance of acne scars, patient's satisfaction, and quality of life.

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No author has any financial interest or received any financial benefit from this research.

Conflict of interest

The authors state no conflict of interest.

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