Original Article

A Prospective, Nonrandomized, Open-label Study, Comparing the Efficacy, Safety, and Tolerability of Fractional CO_2 Laser versus Fractional Microneedling Radio Frequency in Acne Scars

Chetan D. Rajput, Sanjay B. Gore, Misha K. Ansari, Swagat M. Shah

Department of Skin and VD, Shri Bhausaheb Hire Government Medical College, Dhule, Maharashtra, India

Abstract

Background: Acne scar is a distressing psychosocial problem, and it has a negative effect on the quality of life. Although variety of approaches are available, demand of less invasive and more effective ways for their treatment is needed. **Objective:** This study aimed to assess and compare the clinical safety, efficacy, and tolerability of fractional carbon dioxide (FCO_2) laser versus fractional microneedling radio frequency (MNRF) in the management of acne scars. **Materials and Methods:** This study was a prospective, observational, nonrandomized, open-labeled study of total 50 patients selected according to Goodman and Baron global qualitative acne scar grading, and they were divided into two groups of 25 each, having Fitzpatrick skin type III–V. A total of four sessions were given for both the groups at an interval of 2 months. The assessment was done by the treating physician as well as by the blinded physician. Both the subjective and the objective assessment was done at the last follow up given at second month of the fourth session. **Results:** The mean score of 25 patients in each group of FCO_2 and fractional MNRF, decreased from 29.24 to 10.7 (i.e., 63.41%) and from 33.24 to 13.04 (i.e., 60.72%), respectively, as calculated by Goodman and Baron quantitative grading assessed by the treating physician ($P = 0.0001$). Grade 4 (>75%) improvement was shown by four patients and Grade 3 improvement (51%–75%) was shown by 14 patients among FCO_2 group, and similarly Grade 4 (>75%) improvement was shown by three patients and Grade 3 improvement (51%–75%) was shown by 12 patients among MNRF group, as observed by a blinded physician ($P = 0.689$). **Conclusion:** Both modalities are equally effective in the treatment of acne scars; however, fractional MNRF having lesser down time and Post inflammatory hyperpigmentation (PIH) among darker skin shades, with good patient satisfaction score, makes it an efficient and safer treatment option as compared to FCO_2.

Keywords: Acne scar, fractional carbon dioxide laser, microneedling radio frequency

Key Message: Fractional MNRF is equally effective as FCO_2 in the management of atrophic acne scars, but lesser side effects and more patient satisfaction is observed in fractional MNRF group.

Introduction

Postacne scars is a distressing cosmetic problem caused by destruction of collagen after inflammatory acne. Many modalities to improve acne scars such as chemical peels, subcision, scar revision, microneedling, and fillers are available, but their outcomes are unsatisfactory, especially in darker skin type. Recently techniques, which works on the principle of neocollagenesis, such as fractional microneedling radio frequency (MNRF) and ablative lasers, such as fractional carbon dioxide (FCO_2) lasers, are boon to treat such acne scars. Although many articles have been published on the use of these ablative lasers for acne scar,[1-5] there are limited data showing comparative study of FCO_2 laser and fractional MNRF. This study

Access this article online

Quick Response Code:

Website: www.jcasonline.com

DOI: 10.4103/JCAS.JCAS_65_19

Address for correspondence: Dr. Chetan D. Rajput, Department of Skin and VD, Shri Bhausaheb Hire Government Medical College, Chakkarbardy, Dhule, Maharashtra, 424001, India.
E-mail: drchetanrajput@yahoo.com

How to cite this article: Rajput CD, Gore SB, Ansari MK, Shah SM. A prospective, nonrandomized, open-label study, comparing the efficacy, safety, and tolerability of fractional CO_2 laser versus fractional microneedling radio frequency in acne scars. J Cutan Aesthet Surg 2021;14:177-83.

was aimed to compare the efficacy, safety, and tolerability of these two modalities among darker skin types.

Many studies have shown effectiveness of fractional MNRF for the treatment of acne scars. Advantages of this modality are that it has reduced down time and reduced side effects, such as PIH due to melanin sparing effect.[6]

Fractional MNRF device works by creating radio frequency thermal zones without epidermal injury that ultimately lead to long-term and controlled dermal remodeling in the form of neoelastogenesis and neocollagenesis.[7] On the contrary, FCO_2 laser has a double effect. Apart from dermal remodeling, it encourages renewable processes of the wound-healing phase initiated by extremely high level of matrix metalloproteinases, which degrades collagenous matrix and incites increased production of myofibroblasts and matrix proteins such as the hyaluronic acid.[2]

Materials and Methods

This prospective, observational, nonrandomized, open-labeled study was carried out to compare the use of FCO_2 and fractional MNRF procedures for the management of acne scar cases attending skin outpatient department (OPD) of a tertiary care center of Government Medical College, located in northern Maharashtra, India. Institutional ethics committee approval was obtained before the study.

The study included cases having acne scars with Grades 2–4 as per Goodman and Barons Qualitative Global Acne Scar Grading System.[8]

Cases of all age-groups, both the genders, and having Fitzpatrick skin types III–V were selected. Cases who had undergone previous treatments, including skin resurfacing procedures, chemical reconstruction of skin scars (CROSS) using trichloroacetic acid, collagen induction therapy using microneedling or any laser therapy, pregnancy, history of breastfeeding, history of use of photosensitizing agents (such as psoralens, amiodarone, and phenothiazines), history of keloidal tendencies, history of pacemaker implantation, and those cases not willing to give consent were excluded from the study. Total 50 cases were enrolled for the study purpose. The cases fulfilling the inclusion criteria were selected for treating with the either FCO_2 or fractional MNRF. The selection of procedure was nonrandomly distributed by selecting patients of almost equal acne scar grades and dividing them into two groups, that is, FCO_2 and fractional MNRF, respectively. The informed valid consent was obtained from each cases. Before initiation of treatment, global acne quantitative score[9] and preprocedural necessary photographs of each cases were recorded.

Preprocedural preparation was performed among all the study cases by cleaning the face with mild soap and applying topical anesthetic cream (combination of lidocaine 2.5% and prilocaine 2.5%) 60 min before the procedure under occlusion.[10]

For the FCO_2 group, participants underwent treatment with CO_2 fractional laser device with wavelength 10,600 nm.

Parameters used in a single session include laser fluence of 18–24 mJ, delivered with 300 Hz frequency with a spot size of 0.5 mm, with double overlap in left to right pattern over each acne scar. After this, an additional delivery of 10 mJ, with a coverage of 10% area/cm^2/pass, with a spot size of 0.6 mm and single overlap, based on previous studies for Asian skin was given.[11] For fractional MNRF, Vivace is used (Food and Drug Administration [FDA] approved), which provides 61 W bipolar radio frequency with mode of 2 MHz, using noninsulated cartridge having 36 needles with 0.3 mm diameter each, red light-emitting diode (LED) light, and having radio-frequency intensity levels from 1 to 10, providing energy from 30 to 61 W.

Parameter includes three passes, subjected by the roller tip depth, measuring 3.5, 2.5, and 1.5 mm over each pass with a variable pulse duration of 400–800 ms and radio-frequency intensity level between 5 and 8.[10] Post procedure, the patients of both groups were instructed for liberal use of broad-spectrum sunscreen of sun protective factor (SPF) 50 every four to five hourly, and avoiding excess sun exposure. They were also instructed for using cold compresses for relieving pain. For auto removal of crust, use of moisturizer twice a day was advised. Posttreatment, strict avoidance of use of bleach creams and peeling agents was explained.

A total of four sessions were given for both the groups at an interval of 2 months, and last follow-up was carried out at the end of 2 months of the fourth session. Side effects of procedure were monitored and recorded as immediately, at 1 week, 4 weeks, and 2 months of each session. At the end of 2 months of last visit, Goodman and Baron quantitative score, photographs of treated cases, and patient satisfaction score were collected and recorded. Photographs were obtained under standardized conditions using identical camera settings, lighting, and patient positioning at each time.

The comparison of outcome by two treatment procedures was assessed by the following classification methods:

1. Reduction in Goodman and Baron quantitative score assessed before and at 2 months of last session of each treatment by treating physician.[9]
2. By using outcome evaluator (dermatologist who is not a part of study) who was kept blinded and asked to compare the photos at baseline and at 2 months of last session, classified according to quartile grading system.[10,11]
3. Subjective assessment was also carried out by asking a prestructured questionnaire to the treated cases at

the end of study, wherein assessment was obtained on a 10-point scale; questions were asked on the depth of scars, side effects, occurrence of new acne lesions, improvements in skin texture, and complexion, and each were given two points.[7]

4. Side effects reported among two procedures were compared among both the procedures.

Statistical analysis: All the collected data were summated and entered into the Microsoft Excel sheet and were analyzed using the Microsoft Excel and GraphPad Prism statistical software, version 7.0. The analyzed data were presented in the form of frequency, percentage, and mean ± standard deviation (SD). Chi-square test and paired Student's *t* test were performed to compare the significant difference for categorical and quantitative data, respectively. Mann–Whitney *U* test was used to compare the grades among two procedures. $P < 0.05$ level was considered as statistically significant for all the tests performed. The results are presented in the form of tables.

Results

Age distribution observed among the selected cases was with a mean of 26.2 years (standard error of mean [SEM] = 1.53) and 26.8 years (SEM = 1.53) in FCO_2 group and fractional MNRF group, respectively ($P = 0.156$). Gender wise distribution shows that 44% male and 56% female were in FCO_2 group, whereas 48% male and 52% female were in fractional MNRF. The distribution for age-group ($P = 01.56$) and gender ($P = 0.77$) was statistically not significant. All the 50 cases enrolled for study purpose were divided in two groups of 25 each, which underwent FCO_2 and fractional MNRF, respectively. Preprocedural quantitative score, that is, before first session, among the two groups shows that the mean score of 29.24 (SD = 10.3 and SEM = 2.05) was observed in FCO_2 laser, whereas a score of 33.24 (SD = 4.7 and SEM = 1.54) was observed in fractional MNRF group [Table 1]. The difference of mean scores among the two groups was not statistically significant ($P = 0.158$).

Quantitative score measured by treating physician at the first session and at the end of 2 months of the last session in both the procedures showed that the mean of score decreased from 29.24 [Figure 1A] to 10.7 [Figure 1B] (63.41%) in FCO_2 and from 33.24 [Figure 2A] to 13.04 [Figure 2B] (60.72%) in fractional MNRF. The change in mean score was significant in both the procedures [Table 2].

Outcome assessed by second physician, who was kept blinded and did grading from the photographs of both the procedures, concluded that cases in Grade 4 improvement (>75% improvement) were 4 (57.1%), Grade 3 (51%–75% improvement) were 14 (53.8%), and Grade 2 (26%–50% improvement) were 7 (43.7%) from FCO_2 laser group as compared to and 3 (42.9%) and 12 (46.2%) and 9 (56.5%) cases of Grade 4, 3, and 2, respectively, from fractional MNRF group.($P = 0.689$); none showed Grade 1 improvement [Table 3].

Results of subjective assessment on questionnaire basis of treated cases at the end of all sessions showed that 15 cases (70%) having score eight or more were in fractional MNRF as compared to 6 (30%) cases having score eight or more from FCO_2 laser. This was statistically significant ($P = 0.002$) [Table 4].

Comparison of side effects [Table 5] observed among two procedures shows that edema immediately after procedure has been observed among 12 cases (48%) from fractional MNRF group as compared to only two cases (8.00%) of FCO_2 group ($P = 0.003$). Crusting or scaling was observed at 1 week of procedure [Figure 3A] and was significantly present in FCO_2 group in all 25 cases (100%), whereas MNRF group showed no such changes. Post-therapy hyperpigmentation and hypopigmentation [Figure 3B] was observed in majority among FCO_2 groups, that is, at the end of first week six cases (24%) and at the end of 2 months of procedure four cases (16%) as compared to one case (4%) and zero case (0%) at the end of 1 week and 2 months, respectively, in fractional MNRF. Aggravation of inflammation of acne at the end of 2 months was observed only in FCO_2 group, that is, seven cases (28%) ($P = 0.009$). Side effects such as crusting resolved by 12 days of post-laser therapy, and post-therapy hyperpigmentation also resolved within 2 months without the use of any additional modalities; however, four cases had PIH even at last follow-up of FCO_2 laser, whereas cases undergoing fractional MNRF showed only mild edema and erythema immediately after the procedure, lasting up to 3–4 days, only two cases were shown to have erythema lasting up

Table 1: Comparison of the clinico-demographic profile of the two groups

Sr. no.	Variables	Fractional CO_2 ($n = 25$)	MNRF ($n = 25$)
1	Age (years)		
	Mean	26.2	26.8
	SD	6.31	7.67
	SEM	1.26	1.53
	Range	16–42	14–43
2	Sex		
	Male	11 (44%)	12 (48%)
	Female	14 (56%)	13 (52%)
3	Grade		
	1	0	0
	2	3	2
	3	10	9
	4	12	14
4	Quantitative score before first session		
	Mean	29.24	33.24
	SD	10.3	4.7
	SEM	2.05	1.54

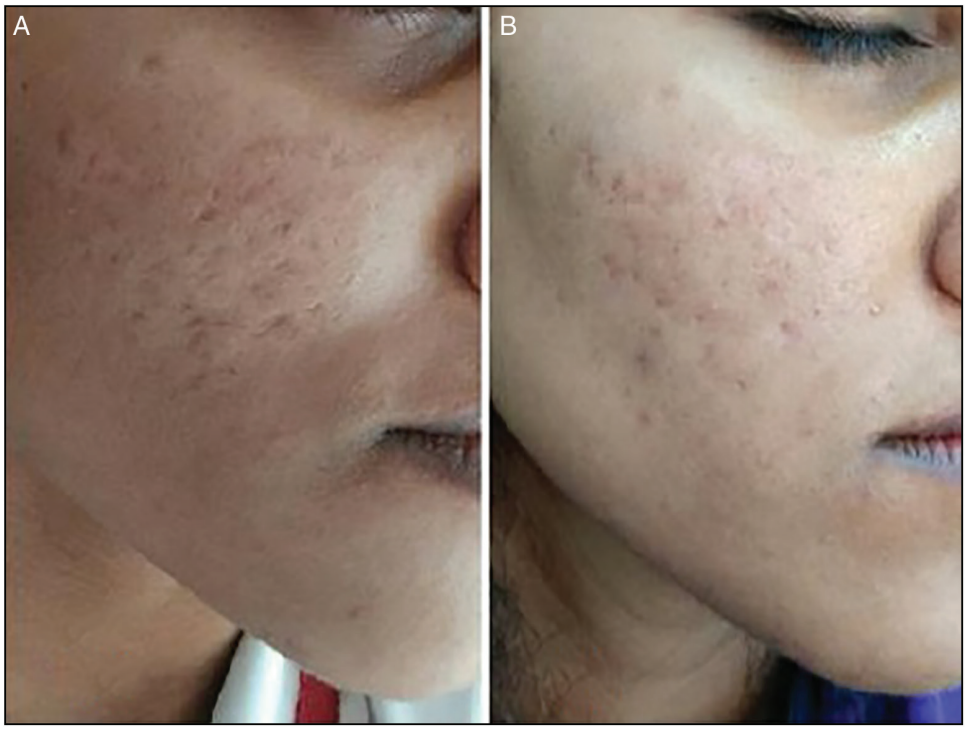

Figure 1: (A, B) Pre- and posttreatment photographs in FCO_2 group

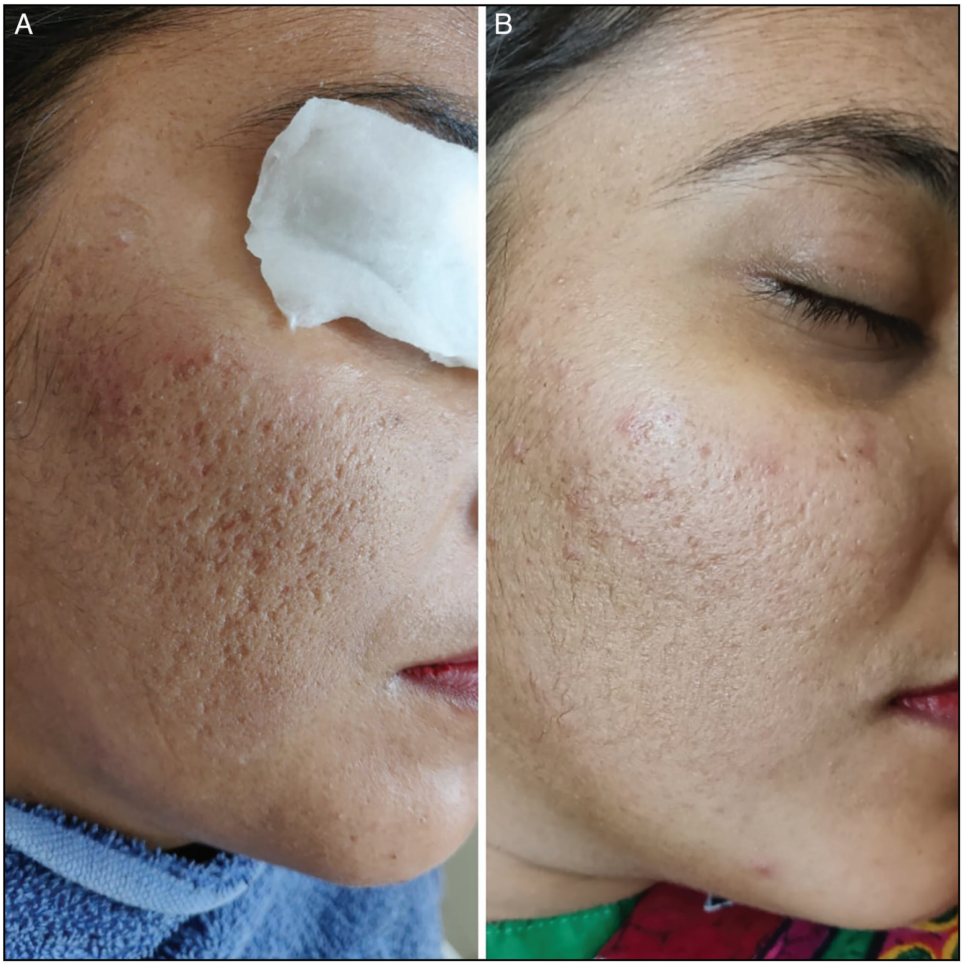

Figure 2: (A, B) Pre and posttreatment photographs in fractional MNRF group

Table 2: Comparison of mean Goodman and Baron quantitative acne scar score assessed by treating physician before and after sessions among cases treated with FCO_2 method and fractional MNRF

Group	Quantitative score		Percentage of reduction in mean score
	Before 1st session	After 4th week of last (4th) session	
	Mean (SEM)	Mean (SEM)	
FCO_2 group	29.24 (2.05)	10.7 (1.1)	63.41%
MNRF group	33.24 (1.54)	13.04 (1.09)	60.72%

Table 3: Outcome evaluation by second physician who was not part of study and was kept blinded at 2 months of last session

Sr. no.	Outcome assessment method	Fractional CO_2 laser (n = 25) N (%)	MNRF (n = 25) N (%)
	Outcome evaluation by second physician who was not part of study		
1	Grade 1 (<25%)	00 (00)	00 (00)
2	Grade 2 (26%–50%)	07 (43.7)	09 (56.5)
3	Grade 3 (51%–75%)	14 (53.8)	12 (46.2)
4	Grade 4 (>75%)	04 (57.1)	03 (42.9)

Table 4: Subjective assessment score at 2 months of last session of the procedure

Sr. no.	Outcome assessment methods	Fractional CO_2 laser (n = 25) N (%)	MNRF (n = 25) N (%)
	Patient (subjective) assessment score		
1	0	0 (00.0)	0 (0.0)
2	2	1 (50.0)	1 (50.0)
3	4	9 (90.0)	1 (10.0)
4	6	9 (64.0)	5 (36.0)
5	8	6 (40.0)	12 (60.0)
6	10	0 (0.0)	3 (100.0)

to 1 week. None of the patient developed posttreatment hyperpigmentation in fractional MNRF.

Overall MNRF is considered as more efficient, better tolerable, and comparatively safer modality of treatment for moderate to severe acne scars in patients having darker skin shades with an added advantage of minimal side effects and maximum patient score of satisfaction.

Discussion

Atrophic scars are faced as a common complication of acne, it can be physically as well as psychological devastating, leading to poor self-esteem, emotional debilitation, social isolation, anxiety, and depression.[6] Laser resurfacing using erbium-doped yttrium aluminum garnet laser is the conventional treatment for acne scar but it carries the drawbacks of long recovery period, dyspigmentation, infection, and prolonged erythema.[12] Ablative 10,600-nm CO_2 fractional laser system has the advantage, above all the other ablative methods, of increasing the effectiveness and reducing the side effects by adopting fractional laser techniques. FCO_2 has dual effects of dermal remodeling and wound healing by production of matrix metalloproteinases. For FCO_2 laser, we used high power and low coverage, which means using high peak powers and short pulse width to destroy intended scar area with little damage to the surrounding tissue to reduce post-inflammatory hyperpigmentation, which is otherwise the most common side effect in darker skin types.[6]

Table 5: Side effects assessed throughout the study

Side effects	Group	
	Fractional CO_2	Fractional MNRF
Immediately post procedure		
Erythema		
Present	24 (96%)	25 (100%)
Absent	1 (04%)	0 (00%)
Edema		
Present	2 (8.00%)	12 (48%)
Absent	23 (92%)	13 (52%)
After 1 week		
Crusting/scaling		
Present	25 (100%)	0 (00%)
Absent	0 (00%)	25 (100%)
Erythema		
Present	2 (08%)	0 (00%)
Absent	23 (92%)	25 (100%)
Post-therapy hyperpigmentation/hypopigmentation		
Present	6 (24%)	1 (04%)
Absent	19 (76%)	24 (96%)
After 4 weeks		
Post-therapy hyperpigmentation/hypopigmentation		
Present	8 (32%)	3 (12%)
Absent	17 (68%)	22 (88%)
At 2 months		
Post-therapy hyperpigmentation/hypopigmentation		
Present	4 (16%)	0 (00%)
Absent	21 (84%)	25 (100%)

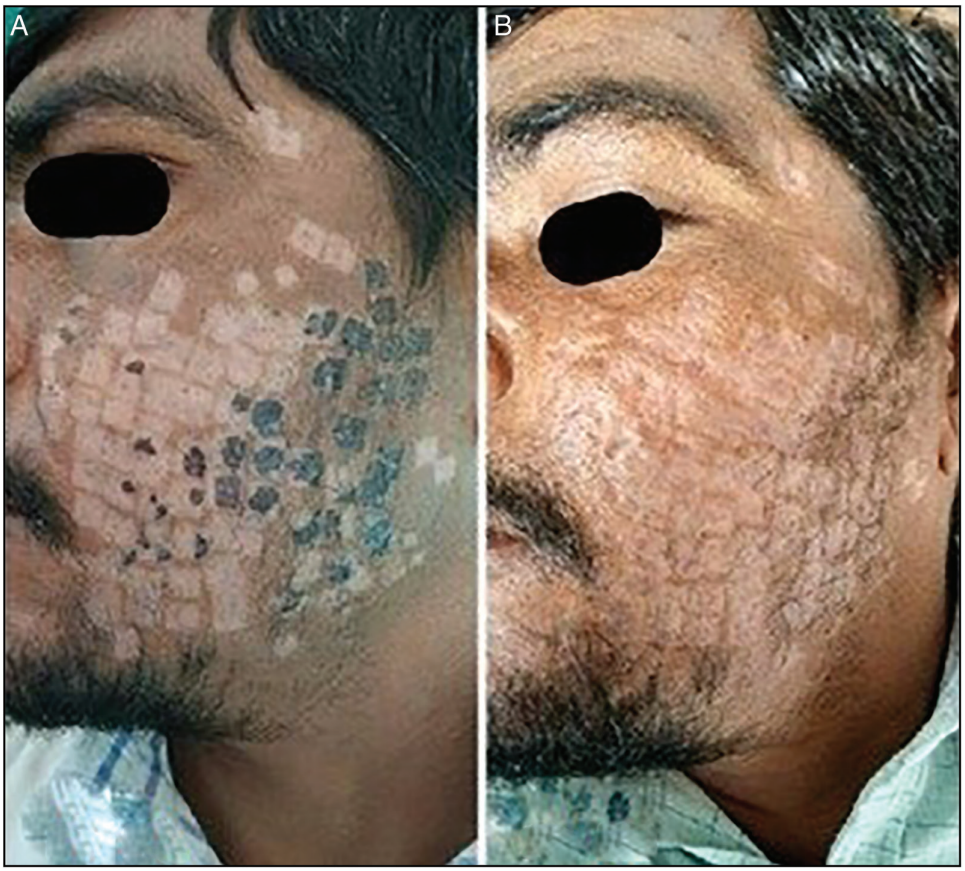

Figure 3: (A) Crusting. (B) Hypopigmentation in FCO_2 group as side effects

MNRF is a novel method for acne scar resurfacing.[1] Needle penetration causes neocollagenesis by stimulating the release of growth factors and sparing of epidermis and adnexal structures, which contributes to rapid healing. Temperature around 60°C can be achieved, leading to partial coagulation without any necrosis. There is minimal epidermal damage with lesser alteration in melanogenesis. Owing to this mechanism and good control over tissue damage results in lesser down time and no post-inflammatory hyperpigmentation. A consistent level of coagulation in the dermis to produce desired effect is achieved due to wide range of exposure time, though the maximum power is more than many other devices.[13] They consist of 36 noninsulated needles, which are better for acne scars compared to insulated needles, which are more effective for remodeling and wrinkle treatment.[10]

From the available literature search, this was found to be the first study to compare the efficacy, tolerability, and safety of FCO_2 and fractional MNRF among darker skin types.

In our study, the mean score of 25 patients in each group of FCO_2 and fractional MNRF decreased from 29.24 to 10.7 (i.e., 63.41%) and from 33.2 to 13.04 (i.e., 60.72%) by global quantitative method. Cameli *et al.* conducted a study in 10 patients with skin phototypes II and III with acne scars that were treated with fractional CO_2 laser and fractionated MNRF, which showed 50% of patients having excellent and 50% good response.[7]

Gold *et al.* conducted a study on mild to moderate acne scars, treated with bipolar fractional radio frequency and concluded that fractional bipolar radio frequency is safe and an effective treatment for acne scars with 67%–92% patient satisfaction.[10]

Cho *et al.*[12] evaluated the efficacy of fractional radio frequency in the treatment of 30 patients with mild to moderate acne scars. The grade of acne scars improved in more than 70% of the patients, thus the overall efficacy of our study is thoroughly consistent with previous studies with a mean improvement of >60% in both groups.

Regarding the side effects, Cho *et al.*[12] observed intense pain post FCO2 laser; however, we observed no pain posttreatment by FCO_2.[10] The duration of post-therapy erythema and scaling was 3–4 days in the fractional MNRF and 1 week in the FCO_2 in a previous study by Zhang *et al.*[6] We observed post-therapy erythema lasting for a mean duration of 6 days post FCO2, whereas in MNRF, the mean duration was of 2 days, which is almost similar to previous studies.

Majid[7] observed that post FCO_2 laser, acneiform eruption developed in 16% patients in his study group, which gradually subsided on oral antibiotics, whereas we found

seven patients (28%) among FCO_2 group developing acneiform eruption.

The end results of our study are consistent with these previous studies.

Overall both the modalities were equally competent in the treatment of acne scars; however, regarding complication, FCO_2 proved to have more duration of crusting and PIH, as a result the patients take longer time to return to their daily chores, as well as their adherence to treatment is hampered, hereto fractional MNRF is most efficient while treating Asian skins for acne scar.

The limitation of this study was that we have not done split face study and histological evaluation of atrophic acne scars after the last session.

Conclusion

FCO_2 and fractional MNRF are equally effective in the treatment of atrophic acne scars; however, fractional MNRF has lesser down time and PIH among darker skin shades with good patient satisfaction score, making it an efficient and safer treatment option as compared to FCO_2 in Fitzpatrick Scale III–V skin types.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Ong MW, Bashir SJ. Fractional laser resurfacing for acne scars: a review. Br J Dermatol 2012;166:1160-9.
2. Petrov A, Pljakovska V. Fractional carbon dioxide laser in treatment of acne scars. Open Access Maced J Med Sci 2016;4:38-42.
3. Ochi H, Tan L, Tan WP, Goh CL. Treatment of facial acne scarring with fractional carbon dioxide laser in Asians, a retrospective analysis of efficacy and complications. Dermatol Surg 2017;43:1137-43.
4. Majid I, Imran S. Fractional CO_2 laser resurfacing as monotherapy in the treatment of atrophic facial acne scars. J Cutan Aesthet Surg 2014;7:87-92.
5. Qian H, Lu Z, Ding H, Yan S, Xiang L, Gold MH. Treatment of acne scarring with fractional CO_2 laser. J Cosmet Laser Ther 2012;14:162-5.
6. Zhang Z, Fei Y, Chen X, Lu W, Chen J. Comparison of a fractional microplasma radio frequency technology and carbon dioxide fractional laser for the treatment of atrophic acne scars: a randomized split-face clinical study. Dermatol Surg 2013;39:559-66.
7. Cameli N, Mariano M, Serio M, Ardigò M. Preliminary comparison of fractional laser with fractional laser plus radiofrequency for the treatment of acne scars and photoaging. Dermatol Surg 2014;40:553-61. doi:10.1111/dsu.12470.
8. Goodman GJ, Baron JA. Postacne scarring: a qualitative global scarring grading system. Dermatol Surg 2006;32:1458-66.
9. Goodman GJ, Baron JA. Postacne scarring—a quantitative global scarring grading system. J Cosmet Dermatol 2006;5:48-52.
10. Faghihi G, Poostiyan N, Asilian A, Abtahi-Naeini B, Shahbazi M, Iraji F, *et al*. Efficacy of fractionated microneedle radiofrequency with and without adding subcision for the treatment of atrophic facial acne scars: a randomized split-face clinical study. J Cosmet Dermatol 2017;16:223-9.
11. Gold MH, Biron JA. Treatment of acne scars by fractional bipolar radiofrequency energy. J Cosmet Laser Ther 2012;14:172-8. doi:10.3109/14764172.2012.687824.
12. Cho SB, Lee SJ, Cho S, Oh SH, Chung WS, Kang JM, *et al*. Non-ablative 1550-nm erbium-glass and ablative 10 600-nm carbon dioxide fractional lasers for acne scars: a randomized split-face study with blinded response evaluation. J Eur Acad Dermatol Venereol 2010;24:921-5.
13. Chandrashekar BS, Sriram R, Mysore R, Bhaskar S, Shetty A. Evaluation of microneedling fractional radiofrequency device for treatment of acne scars. J Cutan Aesthet Surg 2014;7:93-7.