Complications of fractional ablative carbon dioxide laser in various aesthetic procedures: a retrospective study

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ABSTRACT

Background: Though fractionated CO₂ laser technology resurface patients with a lower rate of complications than non-fractionated ablative laser treatment, adverse effects can still occur even with the best technology.

Methods: In this retrospective study we evaluated 65 patients for early and delayed complications after laser treatment with Sellas Cis-FI™ fractional CO₂ laser system of wavelength 106400 nm for various aesthetic indications over the period of 12 months from October 2017 to September 2018. Follow up was done for the period of 2 months after the last session to determine the nature and frequency of various complications. Patient’s subjective assessment of the complications was recorded in the form of patient subjective score (PSS) which ranged from 1 to 10.

Results: In the current study, the most common aesthetic indication for fractional CO₂ laser was post acne scarring (38.4%). The most common early side effects reported were erythema (95.38%) and burning sensation (92.30%) after the procedure. Post procedural dryness and edema was seen in 72.3% and 69.23% patients. Among the delayed complications most frequently observed was persistent erythema (46.15%) followed by post inflammatory hyperpigmentation (44.61%).

Conclusions: Though fractional CO₂ laser is relatively a safe procedure, undesirable sequelae may still occur as a result of inappropriate selection of laser parameter, injudicious patient selection, inadequate preoperative counselling and suboptimal postoperative care. Dermatologist should keep the possibility of all the side effects that can occur after fractional CO₂ laser and must take appropriate precautions during the procedure to avoid them.

Keywords: Microthermal zones, Fractional lasers, Ablative lasers

INTRODUCTION

Fractional ablative CO₂ laser represents one of the significant advances in aesthetic dermatology and has become the treatment of choice for various aesthetic indications. It has offered a bridge between the frankly full ablative lasers and the milder non-ablative lasers. It creates microscopic thermal zones which unlike frankablation are surrounded by normal undamaged skin so that re-epithelization could be achieved sooner.¹ Though fractional lasers represent a better standard of safety than the traditional lasers but they are not without side effects. Most complications arise due to poor intraoperative technique- over stacking of passes, higher than recommended energy or higher density (number of microscopic thermal zones per unit area), failure to adhere to a strict postoperative recovery regimen, mechanical status of the laser, Fitzpatrick skin phototype-dark skin type has higher risk for post inflammatory hyperpigmentation (PIH) after laser therapy.² ⁴ With this perspective, the present study was conducted in an attempt to explore both early and delayed complications.
associated with the use of fractional ablative CO₂ laser in various aesthetic indications.

**METHODS**

In this retrospective study design, after ethical approval from local institute ethical committee, we evaluated 65 patients for early and delayed complications after laser treatment with Sellas Cis-Fl™ fractional CO₂ laser system of wavelength 106400 nm for various aesthetic indications over the period of 12 months from October 2017 to September 2018 at Sri Guru Ram Das Institute of Research and sciences, Amritsar.

**Inclusion criteria**

Patients of age group of 20-40 years and Fitzpatrick skin type IV-VI (Asian population) with following indications for fractional CO₂ laser as acne scars, striae distensae, skin rejuvenation, keloids, traumatic scars and xanthelasma were included.

**Exclusion criteria**

Patients with active local or systemic infections, connective tissue disorders, patients who are pregnant and active dermatoses like psoriasis or vitiligo were excluded.

**RESULTS**

Out of 65 patients, there were 42 females and 23 males with female: male 1.8: 1. Mean age of study population was 26.45±3.67 years. Most of the patients belonged to Fitzpatrick skin type IV (66.15 %) followed by skin type V (18.46%) (Table 2).

In the current study, the most common aesthetic indication for fractional CO₂ laser was post acne scarring (38.4%). The most common early side effects reported were erythema (95.38%) and burning sensation (92.30%) after the procedure. Post procedural dryness and edema was seen in 72.3% and 69.23% patients (Table 3).

Among the delayed complications most frequently observed was persistent erythema (46.15%) followed by post inflammatory hyperpigmentation (44.61%) (Table 4).

**Procedure**

Total number of 4 laser sessions with appropriate parameters (Table 1) was given at an interval of 4 weeks in between the sessions. Follow up was done for the period of 2 months after the last session to determine the nature and frequency of various complications. Patient’s subjective assessment of the complications was recorded in the form of patient subjective score (PSS) which ranged from 1 to 10, 10 representing most severe form of the side effect observed. Results were analyzed using statistical package for social.

**Table 1: Parameters selected for various aesthetic indications.**

| S. No. | Indication       | Area    | Mode           | Pattern       | PPA   | No. of passes | Energy level (millijoules) |
|--------|------------------|---------|----------------|---------------|-------|---------------|---------------------------|
| 1      | Acne scars       | Face    | Stamping       | Scatter       | 49/64 | Single        | 25-50                     |
| 2      | Stretch marks    | Body    | Stamping-moving| Random        | 49/64 | Single        | 25-30                     |
| 3      | Skin rejuvenation| Face    | Moving         | Scatter       | 100/69| Single        | 5-8                       |
| 4      | Keloids          | Body    | Stamping       | Random        | 64/81 | 1-2 passes    | 25-40                     |
| 5      | Traumatic scars  | Body    | Stamping       | Continuous    | 64/81 | 1-2 passes    | 25-40                     |
| 6      | Xanthelasma      | eyelids | Stamping       | Scatter       | 49    | 1-2 passes    | 45-50                     |

**Table 2: Baseline characteristics of study population.**

| Demographic characteristics | Female: male | Mean age (in years) | 26.45±3.67 | Fitzpatrick skin type | No. of patients |
|------------------------------|--------------|---------------------|------------|-----------------------|-----------------|
|                              | Female: male| Mean age (in years) | 26.45±3.67 | Fitzpatrick skin type | No. of patients |
|                              | 1.8: 1      | Mean age (in years) | 26.45±3.67 | IV                    | 43              |
|                              | 50          | Mean age (in years) | 26.45±3.67 | V                     | 12              |
|                              | 1.8: 1      | Mean age (in years) | 26.45±3.67 | VI                    | 10              |
| Indications                  | Acne scars  | 25                  | 25         | Acne scars            | 25              |
|                              | Traumatic scar| 4                  | 4          | Traumatic scar        | 4               |
|                              | Stretch marks| 13                 | 13         | Stretch marks         | 13              |
|                              | Keloids     | 5                   | 5          | Keloids               | 5               |
|                              | Skin rejuvenation| 14             | 14         | Skin rejuvenation     | 14              |
|                              | Xanthelasma | 4                   | 4          | Xanthelasma           | 4               |

**Table 3: Early complications after fractional ablative CO₂ laser.**

| Early complication | N (%) | Mean PSS |
|--------------------|-------|----------|
| Erythema           | 62 (95.38) | 7.23±1.23 |
| Burning            | 60 (92.30)  | 8.34±1.89 |
| Edema              | 45 (69.23)  | 5.34±0.67 |
| Dryness           | 47 (72.30)  | 6.89±1.22 |
| Scabbing          | 47 (72.30)  | 4.32±0.87 |
| Pruritus           | 19 (29.23)  | 4.98±1.23 |
| Petechiae          | 3 (4.61)    | 7.89±1.03 |
| Urticaria          | 2 (3.07)    | 6.03±1.99 |
| Reactivation of herpes simplex | 2 (3.07) | 5.05±1.23 |

PSS: Patient’s subjective score.
Table 4: Delayed complications after fractional ablative CO$_2$ laser.

| Delayed complication                  | N (%)  | PSS         |
|---------------------------------------|--------|-------------|
| Persistent erythema                   | 30 (46.15) | 8.98±1.98  |
| Post-inflammatory hyperpigmentation  | 29 (44.61) | 9.87±0.23  |
| Post-inflammatory hypopigmentation    | 4 (6.15)   | 7.98±2.98  |
| Milia                                 | 19 (29.23) | 5.90±2.23  |
| Acne aggravation                      | 13 (20.0)  | 7.90±2.10  |

PSS: Patient’s subjective score.

DISCUSSION

Though fractional lasers have achieved the goal of developing a system with minimal complications and efficiency as good as ablative lasers, but they are not completely devoid of side effects. The spectra of complications vary from minor post-operative erythema to persistent dyschromia. The majority of complications associated with laser resurfacing are linked to the depth of cutaneous damage, which in turn is linked to the excessive number of passes, higher density (the number of microscopic thermal lesions per area) and fluency used.\textsuperscript{4,5} In the present study immediate side effects like post-operative erythema and burning sensation were reported in most of the patients. Such minor side effects are inevitable due to increased blood flow during the inflammatory response to laser therapy. However persistent erythema lasting for up to a month after the last session has been observed in 46.15% of our patients (Figure 1). In a study done by Metelista et al reported incidence of persistent erythema was slightly lower (25%) patients with average duration of 3.5 months.\textsuperscript{5} High incidence (29.2%) of pruritus and scabbing (73.2%) was seen in our patients owing to dryness, crust formation and irritation induced by laser (Figure 2). These side effects were easily manageable with cold compresses, anti-histaminics and emollients. It is advisable to withhold application of topical corticosteroids after laser therapy to avoid secondary infections. Similar high incidence of pruritus (90%) has been reported in various studies.\textsuperscript{3-6} Post laser edema was seen in 69.23% of the patients which resolved on its own in a week or 2 without any sequel. Reactivation of herpes labialis was reported in 3.07% of the patients. In a study done by Metelista et al herpetic infections occurred after fractional ablative laser and non-ablative laser-based resurfacing in 0.3-2% of cases. Nonetheless, infection rates increased to 2-7% when traditional ablative lasers were used.\textsuperscript{5} Course of antivirals started 2 days before and continued for 7-10 days after the laser resurfacing can prevent reactivation of herpes simplex infections in patients with history of recurrent herpes.\textsuperscript{5} Delayed complications like acne aggravation or milia formation was observed in between 2-8 weeks after laser resurfacing in 20% and 29.9% of patients respectively, which was slightly higher than in other studies.\textsuperscript{5,8} Aberrant follicular re-epitheliazation during healing process can contribute to it (Figure 3).

Non comedogenic and gel based sunscreen and emollients were given in such patients with short course of azithromycin. Oral and topical retinoid were avoided due to reported risk of hypertrophic scarring in damaged skin.\textsuperscript{9} Most feared complication after laser therapy in a...
skin of color is post inflammatory hyperpigmentation which was seen in 30% of patients. Incidence up to as high as 65% has been reported in literature.\(^1,6,10\) Hence appropriate selection of laser parameters is of paramount importance. Kono et al assessed the complications of different energy and density settings of fractional CO\(_2\) laser.\(^6\) Pain, edema, erythema and PIH were more common in patients treated with higher energy and density settings. Various authors recommend adequate detanning before laser resurfacing and use of lower fluencies in patients of skin of color.\(^11\) Various risk factors associated with PIH are tanned skin, operative errors such as higher densities, short pulse interval, higher fluency and overlapping or more no. of passes.\(^5,12\) In present study, patients with PIH were managed conservatively with sunscreen and depigmenting agents such as triple combination creams. In 6.15% of the patients instead of hyperpigmentation, post inflammatory hypopigmentation was seen. Fractional lasers are certainly capable of damaging the skin enough to cause excessive fibrosis and disruption of melanogenesis, resulting in hypopigmentation.\(^13\) In various studies, reported incidence of post laser hypopigmentation was 6-20%.\(^5,7,14,15\) In order to avoid hypopigmentation, the procedure must be carried out within cosmetic units. It is also important to highlight that the mandibular line is very susceptible to hypopigmentation and scars, so it must always be treated with a single laser pass only.\(^5\)

**CONCLUSION**

When used according to appropriate parameters, fractional ablative CO\(_2\) laser resurfacing is relatively safe procedure than traditional CO\(_2\) lasers but is not completely devoid of complications.

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**Ethical approval: The study was approved by the institutional ethics committee**

**REFERENCES**

1. Manstein D, Herron GS, Sink RK, Tanner H, Anderson RR. Fractional photothermolysis: A new concept for cutaneous remodeling using microscopic patterns of thermal injury. Lasers Surg Med. 2004;34(5):426-38.
2. Manuskiatti W, Triwongwaramat D, Varothai S, Eimpunth S, Wanithphakdee Decha R. Efficacy and safety of a carbon-dioxide ablative fractional resurfacing device for treatment of atrophic acne scars in Asians. J Am Acad Dermatol. 2010;63(2):274-83.
3. Tanzi EL, Alster TS. Single-pass carbon dioxide versus multiple-pass Er: YAG laser skin resurfacing: A comparison of postoperative wound healing and side-effect rates. Dermatol Surg. 2003;29(1):80-4.
4. Rendon-Pellerano ML, Lentini J, Eaglstein WE, Kirnser RS, Hanft K, Pardo RJ. Laser resurfacing: usual and unusual complications. Dermatol Surg. 1999;25(5):360-7.
5. Metelitsa AI, Alster TS. Fractionated laser skin resurfacing treatment complications: a review. Dermatol Surg. 2010;36(3):299-306.
6. Kono T, Chan HH, Groff WF, Manstein D, Sakurai H, Takeuchi M, et al. Prospective direct comparison study of fractional resurfacing using different fluences and densities for skin rejuvenation in Asians. Laser Surg Med. 2007;39(4):311-4.
7. Zhang AY, Obagi S. Diagnosis and management of skin resurfacing– related complications. Oral Maxillofac Surg Clin North Am. 2009;21(1):1-12.
8. He SY, McCulloch CE, Boscardin WJ, Chren MM, Linos E, Arron ST. Self-reported pigmentation phenotypes and race are significant but incomplete predictors of Fitzpatrick skin phototype in an ethnically diverse population. J Am Acad Dermatol. 2014;71(4):731-7.
9. Kim YJ, Lee HS, Son SW, Kim SN, Kye YC. Analysis of hyperpigmentation and hypopigmentation after Er: YAG laser skin resurfacing. Lasers Surg Med. 2005;36(1):47-51.
10. Alster TS, West TB. Resurfacing of atrophic facial acne scars with a high-energy, pulsed carbon dioxide laser. Dermatol Surg. 1996;22(2):151-5.
11. Setyadi HG, Jacobs AA, Markus RF. Infectious complications after nonablative fractional resurfacing treatment. Dermatol Surg. 2008;34(11):1595-8.
12. Alam M, Pantanowitz L, Harton AM, Arndt KA, Dover JS. A prospective trial of fungal colonization after laser resurfacing of the face: correlation 134 between culture positivity and symptoms of pruritus. Dermatol Surg. 2003;29(3):255-60.
13. Graber EM, Tanzi EL, Alster TS. Side effects and complications of fractional laser photothermolysis: experience with 961 treatments. Dermatol Surg. 2008;34(3):301-7.
14. Griffin AC. Laser resurfacing procedures in dark-skinned patients. Aesthet Surg J. 2005;25(6):625-7.
15. Kim BJ, Lee DH, Kim MN, Song KY, Cho WI, Lee CK, et al. Fractional photothermolysis for the treatment of striae distensae in Asian skin. Am J Clin Dermatol. 2008;9:33-7.

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