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EFFICACY OF FRACTIONAL CO2 LASER IN TREATMENT OF STRIAE DISTENSAE

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Abstract:

Background: Striae distensae, or stretch marks, are common dermal lesions resulting from skin stretching and are often associated with aesthetic concerns and psychological distress. Fractional CO_2 laser therapy has been mostly used as a promising treatment for promoting collagen remodeling and improving skin texture with minimal time. **Method:** A prospective observational study was done in the Department of Dermatology at Sri Siddhartha Medical College, Tumkur, to evaluate the efficacy of fractional CO_2 laser in treating striae distensae. Patients with >18 years and clinically diagnosed with striae alba were enrolled for the study. Each patient underwent up to three sessions of fractional CO_2 laser at four-week intervals. Clinical improvement was assessed using a global improvement scale, changes in striae surface area, and a Visual Analog Scale (VAS) for patient satisfaction. Adverse effects were also recorded. **Results:** Most patients showed significant clinical improvement post-treatment, with reductions in striae surface area and high patient satisfaction. The majority reported moderate to good improvement, and only a few experienced minimal changes. Adverse effects were generally mild and self-limiting. **Conclusion:** Fractional CO_2 laser therapy is an effective, safe, and well-tolerated modality for the treatment of striae distensae, offering substantial clinical and cosmetic benefits.

Keywords: Fractional CO_2 laser therapy, Striae distensae, laser therapy

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Introduction

Striae distensae, commonly known as stretch marks, are dermal scars resulting from excessive skin stretching due to pregnancy, rapid weight changes, puberty, or corticosteroid use. These atrophic linear lesions mostly lead to cosmetic concerns and psychological distress, and increase the need for effective treatment modalities.[1]

Fractional CO_2 laser therapy has been increase as a promising intervention for the management of striae distensae. By creating controlled microthermal zones in the dermis, this laser stimulates collagen remodeling and elastin synthesis, and this lead to skin regeneration and improved texture. In contrast to traditional ablative lasers, fractional CO_2 laser offers a balance between efficacy and safety, minimizing downtime while achieving significant clinical improvement.[2]

This study aims to evaluate the efficacy of fractional CO_2 laser in the treatment of striae distensae by assessing clinical outcomes, patient satisfaction, and potential adverse effects. By analyzing objective improvements in skin texture and pigmentation, this research done to establish the role of fractional CO_2 laser as a reliable therapeutic option for striae distensae.

Method

This prospective comparative observational study was done in the Department of Dermatology at Sri Siddhartha Medical College, Tumkur, following ethical approval (Ref. No.: SSMC/MED/IEC-063/March-2023). Patients presenting with striae alba

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in the outpatient department were screened, and those meeting the inclusion criteria were enrolled after obtaining written informed consent. The study included patients aged 18 years and older with clinically diagnosed striae alba, while individuals with photosensitivity disorders, cardiac pacemakers, or active infections at the treatment site were excluded. The sample size was determined based on a reference study by Sany et al., leading to the inclusion of 78 striae, accounting for a 10% dropout rate.[3] Purposive sampling was used for patient selection, and the study was done over 18 months.

A detailed history was recorded, including the onset, duration, distribution, and progression of striae alba. Clinical examination assessed the size, shape, location, and type of lesions. patients were given fractional CO_2 laser therapy. Fractional CO_2 laser was administered with initial parameters of 15 joules, 1 millisecond, and 600 micrometers, which were adjusted based on patient response.

Patients underwent treatment at four-week intervals for a maximum of three sessions. Clinical assessments were done at each follow-up, and standardized digital photographs were taken before and after each session using a Nikon camera with consistent settings. The clinical improvement of striae was evaluated using a global improvement scale: weak (0-25%), moderate (25-50%), good (50-75%), and excellent (>75%).[4] Patient satisfaction was assessed using a Visual Analog Scale (VAS) ranging from 0 (no improvement) to 10 (complete improvement).[5] The surface area of the striae was measured using transparent oil paper to trace the lesion, which was then overlaid on 5 mm graph paper to determine the area in mm^2. Patients were monitored for adverse effects, including erythema, edema, pain, and post-inflammatory hyperpigmentation. Patient satisfaction scores were recorded on a 4-point scale, ranging from excellent improvement (4) to no change (1) or aggravation (0).

All collected data were recorded in Microsoft Excel and analyzed using SPSS version 22. Numerical variables were expressed as mean and standard deviation, while categorical variables were presented as frequencies and percentages. ANOVA tests was applied to compare mean surface area of striae over different follow up and Chi-square test was applied to find difference in Clinical Improvement of Striae from baseline to post-treatment, and a p-value <0.05 was considered statistically significant.

Result

Table 1: Demographic Characteristics of Patients in the CO_2 Laser Group

Parameter	Mean ± SD / Frequency (%)
Age (years)	26.4 ± 5.8
Gender (Male/Female)	10 (25.6%) / 29 (74.4%)
BMI (kg/m²)	24.8 ± 3.1
Duration of Striae (months)	18.6 ± 7.3
Family History of Striae	14 (35.9%)

The mean age of patients treated with CO_2 laser was 26.4 ± 5.8 years, with a majority being female (74.4%). The mean BMI was 24.8 ± 3.1 kg/m². The duration of striae varied, with a mean of 18.6 ± 7.3 months. Approximately 35.9% of patients had a positive family history of striae.

Table 2: Baseline Characteristics of Striae Alba in CO_2 Laser Group

Parameter	Mean ± SD / Frequency (%)
Length of Striae (cm)	6.3 ± 2.1
Width of Striae (mm)	2.4 ± 0.8
Common Site Affected	Abdomen (45%), Thighs (30%), Arms (25%)
Associated Symptoms (Itching/Burning)	12 (30.8%)

On average, patients had striae alba with a mean length of 6.3 ± 2.1 cm and width of 2.4 ± 0.8 mm. Abdomen (45%), was the most commonly affected site, followed by thighs (30%) and arms (25%). Approximately 30.8% of patients had itching or burning.

Table 3: Clinical Improvement of Striae Alba After Fractional CO_2 Laser Therapy

Improvement Grade	Baseline (n=39)	Post-Treatment (n=39)
Weak (0-25%)	39 (100%)	6 (15.4%)
Moderate (25-50%)	0 (0%)	15 (38.5%)
Good (50-75%)	0 (0%)	12 (30.8%)
Excellent (>75%)	0 (0%)	6 (15.4%)
P value	<0.001	

At baseline, all patients had significant striae alba. After treatment, 38.5% showed moderate improvement, 30.8% had good improvement, and 15.4% achieved excellent results. The improvement was statistically significant ($p < 0.001$).

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Table 4: Reduction in Striae Surface Area (mm²) Before and After Treatment

Timepoint	Mean Surface Area (mm²) ± SD
Baseline	154.2 ± 21.7
After 1st Session	126.8 ± 18.5
After 2nd Session	99.4 ± 16.8
After 3rd Session	76.2 ± 14.5
P value	<0.001

The mean surface area of striae significantly reduced from 154.2 ± 21.7 mm² at baseline to 76.2 ± 14.5 mm² after the third session ($p < 0.001$), showing the effectiveness of fractional CO_2 laser therapy.

Table 5: Patient Satisfaction Scores After CO_2 Laser Treatment

VAS Score (0-10)	Number of Patients (n = 39)	Percentage (%)
0-2 (No Improvement)	6	15.4%
3-5 (Mild Improvement)	12	30.8%
6-8 (Moderate Improvement)	14	35.9%
9-10 (Significant Improvement)	7	17.9%

The majority of patients (35.9%) reported moderate improvement (VAS 6-8), while 17.9% reported significant improvement (VAS 9-10). However, 15.4% of patients reported little to no improvement (VAS 0-2).

Table 6: Adverse Effects Observed After CO_2 Laser Therapy

Adverse Effect	Number of Patients (n = 39)	Percentage (%)
Erythema	22	56.4%
Edema	10	25.6%
Pain	16	41.0%
Post-inflammatory Hyperpigmentation (PIH)	8	20.5%
No Side Effects	12	30.8%

The most common adverse effect observed was erythema (56.4%), followed by pain (41.0%) and edema (25.6%). Post-inflammatory hyperpigmentation (PIH) was noted in 20.5% of patients. However, 30.8% of patients did not report any adverse effects.

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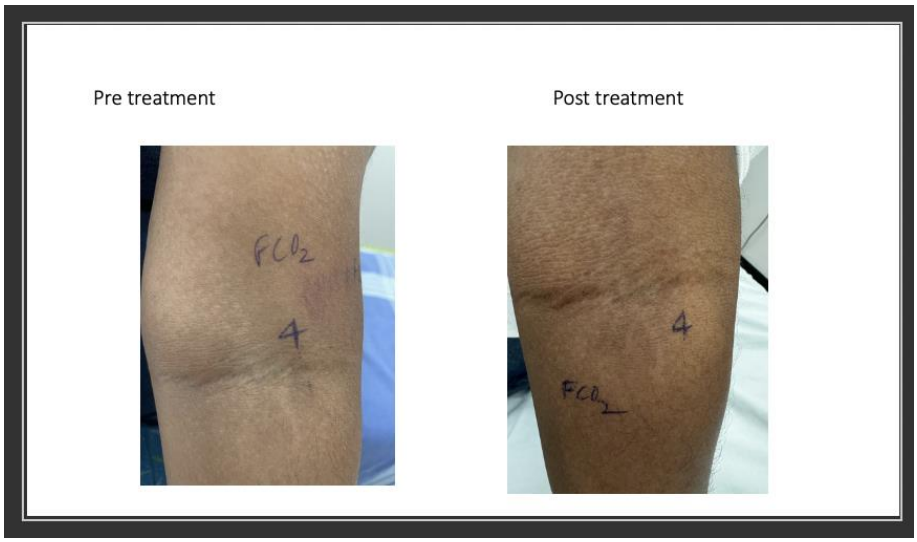

Discussion

Striae distensae, commonly known as stretch marks, are linear dermal scars that arise from rapid skin stretching due to various factors including pregnancy, adolescence, weight fluctuations, and hormonal changes.[6] These lesions, while typically asymptomatic, often cause significant cosmetic concerns, prompting individuals to seek various treatment options.[7] Fractional carbon dioxide (CO_2) laser therapy has emerged as a popular ablative resurfacing technique that utilizes fractional photothermolysis to stimulate collagen production and improve the texture and appearance of the skin.[8]

The study involved 39 patients treated with fractional CO_2 laser. When comparing the clinical improvement observed in this study with findings from other research, several points of interest emerge. A study investigating the efficacy of combined fractional CO_2 laser and radiofrequency (RF) reported moderate improvement in 55.5% and marked improvement in 22.5% of patients.[7] The higher rates of moderate and marked improvement in this combined modality show a potential synergistic effect where the addition of RF energy to fractional CO_2 laser therapy might enhance the overall outcome for treating striae distensae. Fractional CO_2 laser primarily induces collagen remodeling through ablation and thermal stimulation, while RF energy penetrates deeper into the dermis, potentially leading to further collagen denaturation and neocollagenesis.

Our study on the efficacy of fractional CO_2 laser therapy for striae alba showed significant clinical improvement, reduction in striae surface area, and high patient satisfaction, with minimal adverse effects. similar to our study, Elsadek et al. compared fractional CO_2 laser with carboxytherapy noted a "high percentage" of excellent improvement with the laser treatment.[8]

Our study showed that 84.6% of patients achieved moderate to excellent improvement after three sessions of fractional CO_2 laser therapy. This is

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similar to Lee et al. (2010), who reported 59.3% of patients achieving ≥50% improvement after a single session of fractional CO_2 laser.[9] The higher efficacy observed in our study may be due to multiple treatment sessions, which allow for cumulative collagen remodeling and enhanced neocollagenesis.

In comparison, Shin et al. (2014) evaluated succinylated atelocollagen combined with fractional CO_2 laser and reported similar clinical improvement rates, showing that adjunctive therapies may further enhance outcomes.[10] However, our study's standalone CO_2 laser therapy outcomes remain competitive, showing its efficacy as a monotherapy.

Our study show a progressive reduction in striae surface area from 154.2 ± 21.7 mm^2 at baseline to 76.2 ± 14.5 mm^2 after three sessions, with statistical significance ($p < 0.001$). Fatemi Naeini et al. (2016) similarly reported significant reductions in surface area when combining fractional microneedling radiofrequency (FMR) with CO_2 laser therapy compared to FMR alone ($p = 0.003$).[11]

Other studies have reported comparable reductions using alternative lasers. For example, Campbell & Goldman (2010) found that fractional CO_2 laser improved texture and appearance of mature striae distensae in skin types I–IV, [12] while Luo et al. (2023) highlighted the superiority of Er:Glass laser over CO_2 laser for width reduction in certain cases. Despite these findings, our study's results reinforce the robust efficacy of fractional CO_2 laser therapy for surface area reduction.[13]

Patient satisfaction scores in our study were high, with 53.8% reporting ≥6/10 on the VAS scale. Lee et al. (2010) similarly reported 74.1% satisfaction rates, though their single-session protocol elicited lower improvement grades compared to our multi-session approach.[9] Interestingly, Yang & Lee (2011) found no statistically significant difference in satisfaction between CO_2 fractional laser and nonablative fractional laser treatments, highlighting the importance of individualized treatment plans.[14]

In contrast, Khater et al. (2016) reported lower satisfaction rates for CO_2 laser therapy compared to microneedling, showing that microneedling may be a more economical yet effective alternative for certain populations.[15] However, our study's satisfaction scores remain competitive within the broader literature.

Our study reported common adverse effects such as erythema (56.4%), pain (41%), and post-inflammatory hyperpigmentation (PIH, 20.5%), consistent with Chan et al.'s (2010) findings of transient PIH rates reaching 55% at one month post-treatment, which decreased to 11% at six months post-treatment.[16] Similarly, Campbell & Goldman (2010) noted prolonged erythema and edema as typical side effects of fractional CO_2 therapy. [12]

Comparison with Other Modalities, A comparative study by Campbell & Goldman (2010) found that fractional CO_2 laser was more effective than IPL for treating striae distensae after five sessions versus ten IPL sessions ($p < 0.05$).[12] Our findings shows this superiority by showing significant improvement after just three sessions.

A randomized clinical trial by Saki et al. showed no statistically significant difference between microneedling and fractional CO_2 laser in terms of efficacy but highlighted microneedling as a more economical option for striae alba treatment. Luo et al. (2023) reported better efficacy for Er:Glass laser in reducing striae width compared to CO_2 laser but noted comparable results for depth reduction. [13]

Furthermore, a study that compared fractional CO_2 laser alone versus fractional CO_2 laser combined with platelet-rich plasma (PRP) reported moderate improvement in 25%, good improvement in 58.3%, and excellent improvement in 16.7% of patients treated with fractional CO_2 laser alone at 24 weeks.[17] The notably higher percentage of patients achieving "good" improvement in this study (58.3%) compared to the current study (30.8%) shows that various factors can influence treatment outcomes. These factors could include differences in the Fitzpatrick skin types of the patients, the number of treatment sessions administered, the specific laser parameters employed, or the assessment scales used to evaluate improvement.

The consistency in reporting higher improvement rates with the combined fractional CO_2/RF approach across multiple sources [7] strengthens the argument for its potential advantage over fractional CO_2 laser alone. The different mechanisms of action of these two energy-based modalities likely target distinct aspects of striae pathology, potentially leading to a more comprehensive improvement in the appearance of stretch marks. Additionally, research shows that combining fractional CO_2 laser with topical treatments like Centella asiatica can be effective, and other modalities such as Fractional Micro-needle Radiofrequency (FMR) might offer comparable efficacy.[18] FMR stimulates collagen production through microneedle-induced micro-injuries and RF delivery, representing an alternative approach to dermal remodeling.

The current study observed a substantial reduction in the mean surface area of striae, from 154.2 ± 21.7

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mm² to 76.2 ± 14.5 mm², representing an approximate percentage reduction of 50.6%. Other studies have also investigated this quantitative aspect of improvement. Research comparing fractional CO_2 laser to microneedling combined with PRP reported a 33.9% reduction in the Atwal and Davey score with fractional CO_2 laser.[19]

Another study focusing on fractional CO_2 laser for striae alba reported a significant decrease in the mean striae surface area of -37.1 cm² after five treatment sessions.[20] The larger absolute reduction observed in this study compared to the current one (0.78 cm²) could be due to differences in the initial size of the treated striae or the greater number of treatment sessions administered.

Patient satisfaction is a important outcome measure in aesthetic treatments. In the current study, 53.8% of patients reported moderate to significant improvement following fractional CO_2 laser therapy. A study comparing fractional CO_2 laser with long-pulsed Nd:YAG laser found higher patient satisfaction scores with the Nd:YAG laser [6], showing that other laser modalities might be preferred by some patients. However, another study reported a patient satisfaction rate of 59.9% in the fractional CO_2 laser group, which is slightly higher than the rate observed in the current analysis.[19] This shows a generally positive trend in patient satisfaction with fractional CO_2 laser for striae. Research comparing fractional CO_2 laser with and without PRP found better satisfaction scores with the combined treatment (83.3%) compared to fractional CO_2 laser alone (66.7%).[17] The 66.7% satisfaction rate with fractional CO_2 laser alone in that study is also higher than the 53.8% in the current study, which could be due to variations in patient expectations or the specific VAS scales used for assessment. A meta-analysis comparing fractional CO_2 laser and micro-needling found no significant difference in patient satisfaction scores between the two modalities [21], showing that less invasive treatments can achieve comparable levels of patient satisfaction.

The common sites affected by striae in the current study were the abdomen, thighs, and arms. This distribution is similar to findings from other studies that report these areas, along with the breasts, buttocks, and calves, as frequent locations for stretch marks.[7] The specific location can be influenced by the underlying cause, such as pregnancy or adolescent growth spurts.[22] Notably, the treated sites reported in another study closely mirrored the affected sites in the current analysis, further confirming the abdomen, thighs, and arms as the most commonly targeted areas for striae treatment.[19]

The adverse effects observed in the current study, including erythema, pain, edema, and PIH, are consistent with the known side effects of fractional CO_2 laser therapy reported in the literature.[22] However, the reported rates of these effects can vary. A study on various aesthetic showions of fractional CO_2 laser reported higher rates of erythema, edema, and PIH compared to the current study [23], possibly due to differences in treatment parameters or the specific condition being treated. Another study focusing on striae found a higher incidence of PIH but a lower rate of pain.[24] These variations show the influence of factors such as laser settings, patient skin type, and post-treatment care on the occurrence and severity of adverse events.

Conclusion

This study confirms that fractional CO_2 laser therapy is an effective and well-tolerated treatment option for striae distensae, particularly for striae alba. Most patients experienced visible clinical improvement in the appearance of their stretch marks following multiple treatment sessions. The therapy also led to a noticeable reduction in the surface area of the lesions over time. Patient satisfaction levels were generally high, and the treatment was associated with minimal and manageable side effects. Overall, fractional CO_2 laser shows significant potential as a non-invasive and reliable therapeutic modality for improving the appearance of striae distensae.

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