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Efficacy of Fractional Erbium Laser Combined with PRP Therapy in the Treatment of Melasma: A Comparative Study

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Abstract **Original Research Article**

Background: The combination of fractional Erbium laser therapy and platelet-rich plasma (PRP) has shown efficacy in treating skin conditions such as melasma. Erbium laser regenerates and remodels tissue stimulate rejuvenation, while PRP can improve healing and skin regeneration. ***Aim of the study:*** The aim of this study was to assess the efficacy of fractional erbium laser combined with PRP therapy in the treatment of melasma. ***Methods:*** This cross-sectional study was conducted in Department of Dermatology, Bangladesh Specialist Hospital, Dhaka, Bangladesh, from May 2022 to April 2024, including 60 melasma patients. Participants were divided into two groups of 30 each: Group A received only Fractional Erbium Laser therapy, while Group B received the therapy combined with PRP. ***Result:*** In this study, mean ages in group A and group B were 35.8 (± 8.2) and 36.4 (± 7.9), respectively. Initial MASI scores were 15.2 (± 3.6) for group A and 15.5 (± 3.4) for group B. Significant MASI reduction was seen in the group B at 7.2 (± 2.4) versus 9.5 (± 2.5) in the group A ($p = 0.02$). Satisfaction was higher in group B, with 30% reporting "very satisfied" versus 10% in the group A ($p = 0.04$). Adverse events, including erythema and PIH, were lower in group B. Recurrence rates at three months favored group B (80% no recurrence, $p = 0.04$). ***Conclusion:*** The study concludes that combining Fractional Erbium Laser therapy with PRP significantly enhances treatment outcomes for melasma compared to laser monotherapy.

Keywords: Efficacy, Fractional Erbium Laser, PRP Therapy, and Melasma.

INTRODUCTION

Melasma is a chronic skin disorder characterized by symmetrical hyperpigmentation on sun-exposed areas of the face, primarily affecting the cheeks, forehead, and nose, which presents as brown or gray-brown patches that can significantly impact an individual's appearance and quality of life [1,2] This condition disproportionately affects women and is particularly prevalent among individuals with darker skin tones (Fitzpatrick skin types III–V), often exacerbated by ultraviolet (UV) exposure and hormonal influences, such as pregnancy and oral contraceptive use [3,4]. The South Asian population, which includes Bangladesh, exhibits a high prevalence of melasma, attributed to environmental factors like intense UV exposure, combined with genetic predisposition in this [5]. Traditional therapeutic options for melasma have varied in efficacy and often entail significant limitations. Topical agents such as hydroquinone, corticosteroids, and retinoids have been widely used due to their ability to inhibit tyrosinase, an enzyme critical in melanin synthesis [6,7]. However, the effectiveness of hydroquinone-based treatments is often limited by skin irritation and recurrence once the treatment is discontinued [8]. Other non-invasive approaches, including chemical peels and microdermabrasion, offer mixed results and pose risks of post-inflammatory hyperpigmentation (PIH) [9]. Laser therapies have shown promise by targeting pigmentation at a deeper level, with Fractional Erbium and CO_2 lasers emerging as effective options for reducing hyperpigmentation and improving skin texture. The Fractional Erbium Laser, in particular, has gained attention for effectively reducing pigmentation while lowering the risk of PIH, making it a safer option for darker skin types [10,11]. Erbium Lasers create microscopic heat columns causing areas of thermal damage known as Microscopic treatment zones (MTZs). These MTZs range from 100-400 µm in width, and approximately 300-700 µm in depth. The MTZs are separated by zone of normal skin which acts as a reservoir for tissue regeneration and remodeling. These

mechanisms enhance skin texture and support collagen synthesis, addressing melasma and skin rejuvenation [12]. Platelet-rich plasma (PRP) therapy has emerged as a promising complementary option, leveraging the patient's own platelets to deliver a high concentration of growth factors directly to the skin. These growth factors stimulate cellular turnover, reduce inflammation, and promote melanocyte regulation, ultimately leading to a reduction in melanin production [13] By promoting collagen production and enhancing the skin's regenerative processes, PRP not only targets pigmentation reduction but also contributes to improved skin quality [14]. Moreover, studies have shown that PRP can effectively mitigate some side effects associated with laser therapy, such as erythema and prolonged edema, when used in conjunction [9,12]. The rationale for combining Fractional Erbium Laser with PRP therapy in melasma treatment lies in their synergistic potential. The laser's micro-injuries create channels that facilitate deeper PRP absorption, maximizing the delivery of growth factors to targeted areas and enhancing the skin's ability to regenerate and repair [12]. By simultaneously targeting melanin production through the laser and supporting cellular repair through PRP, this combination therapy has the potential to yield better clinical outcomes, reducing treatment duration and recurrence rates compared to monotherapies [15,16]. Several studies indicate that combining PRP with lasers for conditions like acne scars results in greater patient satisfaction, faster recovery times, and fewer side effects, making this approach particularly advantageous for sensitive skin types [15,16]. Some meta-analyses have shown that combining PRP with CO_2 fractional lasers significantly enhances clinical improvement rates and patient satisfaction compared to laser therapy alone, offering accelerated recovery and fewer side effects [16,17]. This evidence underscores the potential for similar results in melasma treatment, where the synergy of laser-induced micro-channels and PRP's regenerative properties could address pigmentation while enhancing skin quality, an outcome highly desirable in the treatment-resistant forms of melasma common in Bangladesh [18,19]. This current study seeks to explore the efficacy of fractional erbium laser combined with PRP therapy in the treatment of melasma.

Objectives

To assess the efficacy of fractional erbium laser combined with PRP therapy in the treatment of melasma.

METHODOLOGY & MATERIALS

This cross-sectional study was conducted in Department of Dermatology, Bangladesh Specialist Hospital, Dhaka, Bangladesh, from May 2022 to April 2024. Total 60 patients with clinically diagnosed melasma were included in this study. Participants were divided into two groups, with 30 patients in each group-Group A: Patients receiving Fractional Erbium Laser therapy only and Group B: Patients receiving combined Fractional Erbium Laser therapy with PRP application. Laser parameters were adjusted based on skin type and individual tolerance. Treatment sessions were carried out every four weeks, with each patient receiving a total of three sessions. For Group-B, autologous PRP was prepared from the patient's blood using a centrifugation process to concentrate platelets. Following the Fractional Erbium Laser treatment, PRP was applied topically and massaged into the laser-treated areas to enhance absorption. The PRP application was conducted immediately after laser therapy to take advantage of the microchannels created by the laser, optimizing growth factor penetration. Reduction in melasma severity was measured by the Melasma Area and Severity Index (MASI) scores. Consent of the patients and guardians were taken before collecting data. After collection of data, the data were entered into computer and statistical analysis of the results being obtained by using windows-based computer software devised with Statistical Packages for Social Sciences version 22. P value of less than 0.05 was considered statistically significant. Inclusion criteria included patients having Fitzpatrick skin types III–V, age between 18-60 years, and a stable melasma condition for at least six months. Exclusion criteria included pregnancy, history of hypersensitivity to PRP components, and any recent melasma treatment (topical, laser, or systemic) within the previous three months.

RESULTS

Table I presents the baseline characteristics of the 60 patients enrolled in the study, with 30 patients each in Group A (Laser Only) and Group B (Laser + PRP). The mean age of patients in Group A was 35.8 years (± 8.2), compared to 36.4 years (± 7.9) in Group B, with no statistically significant difference (p = 0.75). The average duration of melasma was slightly longer in Group B at 4.8 years (± 2.5) compared to 4.5 years (± 2.3) in Group A, though this difference was not significant (p = 0.62). Baseline Melasma Area and Severity Index (MASI) scores were similar between the two groups, with Group A recording a mean score of 15.2 (± 3.6) and Group B scoring 15.5 (± 3.4), yielding a p-value of 0.84, indicating no significant baseline difference in severity. Figure 1 demonstrates the gender distribution of the study groups. Group A included 4 male patients (13.3%) and 26 female patients (86.3%), while Group B comprised 5 male patients (16.7%) and 25 female patients (83.3%). The distribution of gender between the groups shows a slight variation but remains relatively balanced, supporting the comparability of the study groups. Overall, these baseline characteristics indicate that the two groups were well-matched at the beginning of the study, ensuring a reliable comparison of treatment outcomes. Table II details the changes in MASI scores over time between Group A (Laser Only) and Group B (Laser + PRP). At baseline, Group A had a mean MASI score of 15.2 (± 3.6), while Group B had a mean score of 15.5 (± 3.4), showing no significant

difference (p = 0.84). After the first treatment session, the scores decreased to 13.4 (± 3.2) in Group A and 12.1 (± 3.0) in Group B, with a p-value of 0.12, indicating no statistically significant change. Following the second session, Group A's mean score reduced further to 11.0 (± 2.8), while Group B's score dropped to 9.3 (± 2.7), achieving borderline significance (p = 0.05). Post-treatment, Group A had a mean score of 9.5 (± 2.5), and Group B had a significantly lower score of 7.2 (± 2.4) (p = 0.02). At the 1-month follow-up, Group A's score slightly increased to 10.0 (± 2.7), whereas Group B maintained a lower mean of 7.5 (± 2.6), with a p-value of 0.01, indicating statistical significance. Table III outlines the patient satisfaction scores between the two groups. In Group A, only 3 patients (10%) reported being very satisfied (Score 5), compared to 9 patients (30%) in Group B, with a significant p-value of 0.04. Satisfaction levels (Score 4) were seen in 12 patients (40%) in Group A and 14 patients (46.7%) in Group B, showing no significant difference (p = 0.32). Neutral satisfaction (Score 3) was noted in 11 patients (36.7%) in Group A and only 5 patients (16.7%) in Group B (p = 0.09). Dissatisfaction (Score 2) was reported by 5 patients (16.7%) in Group A and 2 patients (6.7%) in Group B (p = 0.2). Very dissatisfied patients (Score 1) included 2 (6.7%) in Group A and none in Group B (p = 0.15). Table IV presents the adverse event comparison between the groups. Transient erythema was experienced by 11 patients (36.7%) in Group A and 9 patients (30%) in Group B (p = 0.42). Edema was observed in 6 patients (20%) in Group A and 5 patients (16.7%) in Group B (p = 0.61). Post-inflammatory hyperpigmentation (PIH) occurred in 8 patients (26.7%) in Group A compared to 3 patients (10%) in Group B, with a borderline significant p-value of 0.05. Mild pain was reported by 14 patients (46.7%) in Group A and 10 patients (33.3%) in Group B (p = 0.18). Scarring was rare, affecting only 1 patient (3.3%) in Group A and none in Group B (p = 0.32). Table V compares the recurrence status between the two groups at a 3-month follow-up. No recurrence was noted in 18 patients (60%) in Group A, while 24 patients (80%) in Group B had no recurrence, with a significant p-value of 0.04. Partial recurrence was seen in 9 patients (30%) in Group A and 5 patients (16.7%) in Group B (p = 0.17). Full recurrence was observed in 3 patients (10%) in Group A and 1 patient (3.3%) in Group B (p = 0.47), indicating no significant difference.

Table-I: Baseline characteristics of the study groups (N=60)

Characteristic	Group A (n=30)	Group B (n=30)	p-value
Age (Mean ± SD)	35.8 ± 8.2	36.4 ± 7.9	0.75
Duration of Melasma (years, Mean ± SD)	4.5 ± 2.3	4.8 ± 2.5	0.62
Baseline MASI Score (Mean ± SD)	15.2 ± 3.6	15.5 ± 3.4	0.84

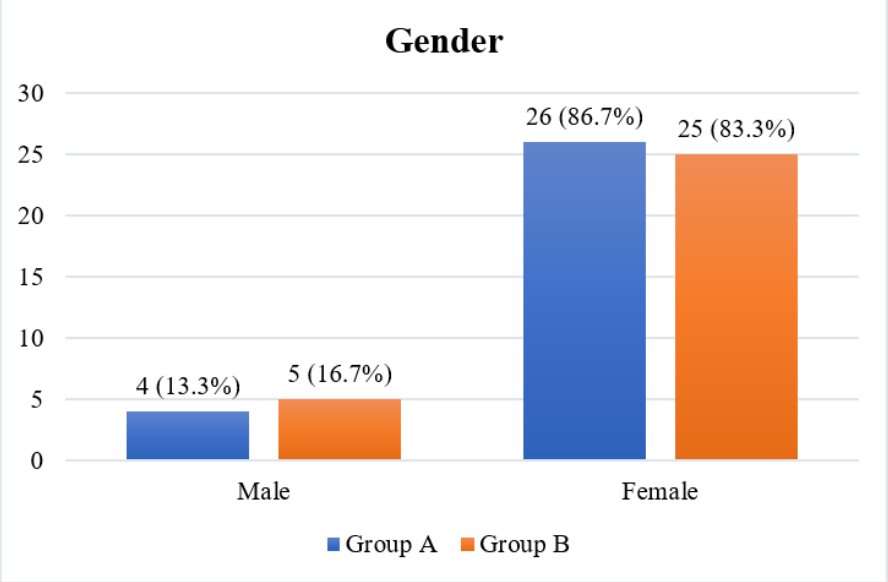

Figure 1: Gender distribution of the study groups (N=60)

Table-II: Comparison of changes in MASI scores over time between the study groups (N=60)

Time Point	Group A (n=30)	Group B (n=30)	p-value
Baseline (Mean ± SD)	15.2 ± 3.6	15.5 ± 3.4	0.84
After 1st Session	13.4 ± 3.2	12.1 ± 3.0	0.12
After 2nd Session	11.0 ± 2.8	9.3 ± 2.7	0.05

Final Session (Post-Treatment)	9.5 ± 2.5	7.2 ± 2.4	0.02
1-Month Follow-Up	10.0 ± 2.7	7.5 ± 2.6	0.01

Table-III: Comparison of patient satisfaction scores between the study groups (N=60)

Satisfaction Level	Group A (n=30)	Group B (n=30)	p-value
Very Satisfied (Score 5)	3 (10%)	9 (30%)	0.04
Satisfied (Score 4)	12 (40%)	14 (46.7%)	0.32
Neutral (Score 3)	11 (36.7%)	5 (16.7%)	0.09
Dissatisfied (Score 2)	5 (16.7%)	2 (6.7%)	0.2
Very Dissatisfied (Score 1)	2 (6.7%)	0	0.15

Table-IV: Comparison of adverse event between the study groups (N=60)

Adverse Event	Group A (n=30)	Group B (n=30)	p-value
Erythema (Transient)	11 (36.7%)	9 (30%)	0.42
Edema	6 (20%)	5 (16.7%)	0.61
Post-Inflammatory Hyperpigmentation (PIH)	8 (26.7%)	3 (10%)	0.05
Pain (Mild)	14 (46.7%)	10 (33.3%)	0.18
Scarring	1 (3.3%)	0	0.32

Table-V: Comparison of recurrence status between the study groups (N=60)

Recurrence Status	Group A (n=30)	Group B (n=30)	p-value
No Recurrence	18 (60%)	24 (80%)	0.04
Partial Recurrence	9 (30%)	5 (16.7%)	0.17
Full Recurrence	3 (10%)	1 (3.3%)	0.47

DISCUSSION

This cross-sectional study was conducted in Department of Dermatology, Bangladesh Specialist Hospital, Dhaka, Bangladesh, from May 2022 to April 2024. The discussion of the current study, which compared the efficacy of Fractional Erbium Laser therapy alone versus its combination with PRP for treating melasma in 60 patients, reveals several significant findings that align with and diverge from prior literature. The baseline characteristics of the patients were well-matched between the Fractional Erbium Laser therapy group and the group of patients receiving combined Fractional Erbium Laser therapy. The mean age was similar between groups, at 35.8 years (± 8.2) for the Fractional Erbium Laser therapy group and 36.4 years (± 7.9) for the combined therapy group, and the duration of melasma showed no significant difference (p = 0.75 and p = 0.62, respectively). This comparability establishes a reliable foundation for evaluating treatment outcomes, as emphasized in studies such as the one by Rho [20], where patient demographics were controlled to assess treatment efficacy. The reductions in MASI scores in this study highlight the superior efficacy of the combination therapy. At baseline, both groups had comparable MASI scores (15.2 ± 3.6 for the Fractional Erbium Laser therapy group and 15.5 ± 3.4 for the combined therapy group, p = 0.84). After the first session, the scores decreased to 13.4 (± 3.2) for the Fractional Erbium Laser therapy group and 12.1 (± 3.0) for the combined therapy group, showing no significant difference (p = 0.12). However, by the second session, the Fractional Erbium Laser therapy group recorded an MASI of 11.0 (± 2.8), while the combined therapy group dropped to 9.3 (± 2.7), approaching statistical significance (p = 0.05). This trend continued post-treatment, with the Fractional Erbium Laser therapy group at 9.5 (± 2.5) and the combined therapy group significantly lower at 7.2 (± 2.4), p = 0.02. A month after the final treatment, the Fractional Erbium Laser therapy group's score increased slightly to 10.0 (± 2.7), while the combined therapy group's remained at 7.5 (± 2.6), achieving statistical significance (p = 0.01). These results corroborate findings from Xi *et al.,* [21], where laser therapy showed significant MASI reductions but reported high recurrence rates, indicating that combination treatments might offer more sustained benefits. Comparative studies like the one conducted by Katz *et al.,* [22] observed moderate to long-term efficacy with fractional photothermolysis, albeit with some recurrence, supporting the finding that combined treatments can yield enhanced outcomes. Furthermore, the current study's findings align with the results of Adel *et al.,* [23], who demonstrated that combining laser therapy with PRP significantly improved pigmentation reduction and patient satisfaction compared to laser monotherapy. Patient satisfaction scores reflected the observed clinical improvements. In this study, 10% of patients in the Fractional Erbium Laser therapy group reported being very satisfied compared to 30% in the group receiving combined therapy (p = 0.04). This mirrors findings from Mohamed *et al.,* [24], who found that combination therapy involving lasers and topical agents led to higher satisfaction due to greater overall efficacy. Additionally, in the Fractional Erbium Laser therapy group, 40% of patients were satisfied, and 36.7% were neutral, compared to 46.7% satisfaction and only

16.7% neutral responses in the combined therapy group. Dissatisfaction was lower in the combined therapy group (6.7%) compared to the Fractional Erbium Laser therapy group (16.7%). These trends highlight the enhanced patient perception of combination treatments, echoing results reported by Parra *et al.*, [25] on the use of low-fluence lasers with supplementary therapies for improved patient satisfaction. Adverse event rates were similar between the two groups, with transient erythema observed in 36.7% of the Fractional Erbium Laser therapy group and 30% of the combined therapy group ($p = 0.42$). Edema was reported in 20% of the Fractional Erbium Laser therapy group and 16.7% of the combined therapy group ($p = 0.61$). Post-inflammatory hyperpigmentation (PIH) was notably lower in the combined therapy group (10%) compared to 26.7% in the Fractional Erbium Laser therapy group ($p = 0.05$). Mild pain was experienced by 46.7% of the Fractional Erbium Laser therapy group and 33.3% of the combined therapy group ($p = 0.18$). The incidence of scarring was minimal, affecting only one patient in the Fractional Erbium Laser therapy group (3.3%). These results align with findings from Hu *et al.*, [26], who noted higher risks of PIH in darker skin types with laser monotherapy, indicating that PRP can help mitigate this risk. Comparative literature, such as Lee *et al.*, [27], reported similar rates of erythema and hyperpigmentation after laser therapy, reinforcing the advantage of combination therapies to reduce these adverse effects. At the 3-month follow-up, recurrence rates further underscored the benefits of combined therapy. No recurrence was observed in 60% of the Fractional Erbium Laser therapy group compared to 80% of the combined therapy group ($p = 0.04$). Partial recurrences were noted in 30% of the Fractional Erbium Laser therapy group and 16.7% of the combined therapy group ($p = 0.17$). Full recurrence occurred in 10% of the Fractional Erbium Laser therapy group and only 3.3% of the combined therapy group ($p = 0.47$). These findings are consistent with the study by Rho [20], which reported recurrence rates of 21.7% after laser treatments, suggesting that while effective initially, combination therapies may provide better long-term stability. The current study supports the hypothesis that combining Fractional Erbium Laser with PRP therapy provides superior outcomes in terms of MASI score reduction, patient satisfaction, lower recurrence, and fewer adverse effects compared to laser monotherapy.

Limitations of the study

In our study, there was small sample size and absence of control for comparison. Study population was selected from one center in Dhaka city, so may not represent wider population. The study was conducted at a short period of time.

CONCLUSION AND RECOMMENDATIONS

The study concludes that combining Fractional Erbium Laser therapy with PRP significantly enhances treatment outcomes for melasma compared to laser monotherapy. Patients receiving combined therapy demonstrated superior MASI score reductions, higher satisfaction rates, fewer adverse effects, and lower recurrence at a 3-month follow-up. Future studies should explore longer follow-up periods and larger sample sizes to validate long-term efficacy and safety.

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