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Comparative Evaluation of Q-Switched Nd:YAG Laser and 50% Glycolic Acid Peel in Melasma: A Prospective Interventional Study

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Abstract: ***Background: Melasma is a chronic, relapsing hyperpigmentation disorder that significantly affects quality of life, especially in individuals with intermediate-to-dark skin types. Procedures like glycolic acid peels and Q-switched Nd:YAG lasers are valuable treatment options, but comparative evidence in Indian patients remains limited. Aim: To compare the efficacy, safety, and tolerability of Q-switched Nd:YAG laser with 50% glycolic acid peel in the treatment of melasma. Methods: In this prospective interventional study, 60 clinically diagnosed melasma patients were randomized into two groups of 30 each: one receiving 50% glycolic acid peels and the other Q-switched Nd:YAG laser therapy. Treatments were administered every 4 weeks for 5-6 sessions in the peel group and 4-5 sessions in the laser group. Standardized MASI scoring, dermoscopic evaluation, and photographic documentation were performed at baseline and at 4-week intervals up to 24 weeks. Results: Both modalities demonstrated statistically significant reductions in MASI scores over 24 weeks ($p < 0.05$). The glycolic peel group showed a more pronounced overall reduction, particularly in mixed and dermal melasma. The laser group exhibited superior outcomes in epidermal melasma. Side effects were mild and transient in both groups, including erythema, dryness, and transient hyperpigmentation. Conclusion: Both Q-switched Nd:YAG laser and 50% glycolic acid peel are safe and effective for melasma management. Glycolic acid peel demonstrated superior overall improvement, whereas Q-switched Nd:YAG laser was most effective for epidermal melasma. Treatment selection should be individualized based on melasma type and skin characteristics.***

Keywords: Melasma, Glycolic acid peel, Q-switched Nd:YAG laser, Hyperpigmentation, MASI score

1. Introduction

Melasma is a common acquired hyperpigmentation disorder characterized by irregular brown to gray-brown macules predominantly involving sun-exposed facial areas. Its prevalence ranges between 1% and 50%, depending on ethnicity, UV exposure, and hormonal influences, and it is most prevalent in women with Fitzpatrick skin types III-V. Genetic predisposition, ultraviolet radiation, pregnancy, oral contraceptives, thyroid dysfunction, and cosmetics have all been implicated in its pathogenesis. Studies by Grimes et al. and Miot et al. demonstrated that melasma skin exhibits elevated melanocyte activity, increased melanin synthesis, and dermal changes including vascular proliferation and solar elastosis.[1,2]Sanchez et al. and Kang et al. highlighted histological disruptions in basement membrane integrity, explaining the chronicity and treatment resistance of melasma.[3,4]

Due to the multifactorial nature of melasma, treatment remains challenging. Topical depigmenting agents such as hydroquinone, kojic acid, and retinoids have been used widely but often yield incomplete or transient results. Procedural modalities, including chemical peels and lasers, have gained prominence in recent years. Glycolic acid, an alpha-hydroxy acid, promotes exfoliation and increases epidermal turnover, leading to dispersion of melanin and absorption enhancement of topical agents. Research by Javaheri et al. and Kalla et al. demonstrated its utility in epidermal and mixed melasma.[5,6] Meanwhile, Q-switched Nd:YAG lasers target melanosomes through selective photothermolysis, fragmenting pigment particles without significant epidermal injury. Studies by Chan et al. and Kim et al. have demonstrated its safety and efficacy in darker skin types.[7,8]

Given the limited comparative data in Indian populations, this study aimed to evaluate and compare the clinical efficacy of Q-switched Nd:YAG laser and 50% glycolic acid peel in melasma. This comparison holds clinical importance for tailoring melasma treatment protocols in darker skin types, particularly within the Indian demographic context.

2. Materials and Methods

This prospective, interventional comparative study was conducted in the Department of Dermatology, Venereology, and Leprology at Basaveshwara Teaching and General Hospital, Kalaburagi, over 18 months. A total of 60 clinically diagnosed melasma patients aged 18 years and above were included after obtaining written informed consent. Patients were randomized equally into two treatment groups using a simple lottery method. Detailed clinical histories, Fitzpatrick skin typing, duration of melasma, past treatments, and trigger factors such as sun exposure, hormonal influences, and cosmetic usage were recorded. Baseline assessments included

standardized clinical photography, dermoscopic evaluation, and MASI scoring. Patients with pregnancy, lactation, oral contraceptive use, active facial dermatoses, hypersensitivity to study procedures, or irregular follow-up were excluded.

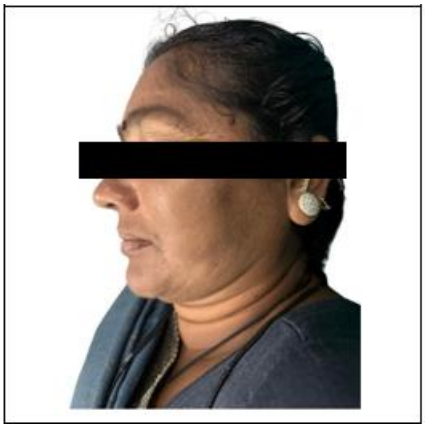
Group A received 50% glycolic acid peels following degreasing and priming; the solution was applied for 2-3 minutes, neutralized with sodium bicarbonate, rinsed with saline, and followed by sunscreen. Group B underwent low-fluence Q-switched Nd:YAG laser therapy using 1064 nm wavelength, fluence of 800-1500 mJ/cm², spot size of 3-4 mm, and frequency of 4-6 Hz. Both treatments were administered every 4 weeks for a total of 5-6 sessions in the peel group and 4-5 sessions in the laser group. Patients were counseled regarding strict photoprotection. Follow-up evaluations, including MASI scoring and dermoscopic analysis, were performed at 4, 8, 12, 18, and 24 weeks. Statistical analysis was conducted using SPSS version 25, with paired t-tests and ANOVA applied as appropriate, considering $p < 0.05$ statistically significant.

3. Results

The study included 60 patients aged between 25 and 50 years, with the highest representation in the 28-29 and 44-45 year age groups. Gender distribution was equal, with 30 females and 30 males. Fitzpatrick skin types II-V were represented almost uniformly, reflecting the regional population profile. The duration of melasma varied between 6 and 36 months, with a significant proportion (21.7%) experiencing symptoms for 36 months. Clinical classification revealed 31.7% epidermal, 33.3% dermal, and 35% mixed melasma.

Both treatment groups demonstrated progressive and statistically significant reductions in MASI scores throughout the 24-week study period. In the glycolic acid peel group, marked improvement was noted as early as the 8-week visit, with sustained reduction thereafter. Mixed and dermal melasma showed the most robust response, with MASI scores decreasing from a baseline mean of 10.25 ± 1.25 to 3.95 ± 0.75 at 24 weeks. The Q-switched Nd:YAG laser group also exhibited significant improvement, particularly in epidermal melasma, though the overall magnitude of MASI reduction was slightly lower than that observed with glycolic peels. Patients tolerated both procedures well, with mild erythema (30%), dryness (25%), and transient hyperpigmentation (25%) reported, all of which resolved spontaneously with conservative care. No serious adverse events occurred.

Before



After

Group A: Patient receiving 50% glycolic acid peel

Before

After

Group B: Patients receiving 1032nm Nd- YAG LASER

4. Discussion

This study demonstrates that both 50% glycolic acid peel and Q-switched Nd:YAG laser are effective in improving melasma, consistent with previous literature. The superior performance of glycolic acid peel in mixed and dermal melasma supports findings by Javaheri et al. and Sharquie et al., who noted enhanced epidermal turnover and improved pigment dispersion with alpha-hydroxy acids.[5,9] Glycolic acid facilitates keratinocyte desquamation and accelerates fading of epidermal pigment while improving penetration of topical agents, which likely explains the significant MASI reduction observed in our study.

The Q-switched Nd:YAG laser group exhibited optimal improvement in epidermal melasma, aligning with earlier studies by Chan et al. and Polnikorn et al., who demonstrated the laser's ability to selectively target melanosomes with minimal thermal damage.[7,10] Low-fluence laser toning, as used in this study, disperses pigment gradually and safely, making it suitable for darker skin types. However, the relatively lower improvement in dermal and mixed melasma may be attributed to deeper pigment deposition, reduced laser penetration, and dermal remodeling variations described by Grimes et al. and Miot et al.[1,2]

Side effects in both groups were mild and transient, in agreement with prior reports. Transient hyperpigmentation was slightly more frequent in the laser group, consistent with the findings of Kim et al., who reported pigmentary rebound in a subset of patients undergoing laser treatments.[8] Dermal changes such as solar elastosis and increased vascularity described by Sanchez et al. and Kang et al. may influence procedural outcomes, highlighting the need for individualized treatment selection based on melasma subtype and skin type.[3,4]

In summary, the results support a personalized, multimodal approach in melasma management, with glycolic peels favored for mixed and dermal melasma and Q-switched Nd:YAG laser representing an excellent option for epidermal melasma.

5. Conclusion

Both Q-switched Nd:YAG laser and 50% glycolic acid peel provide significant clinical improvement in melasma. Glycolic acid peel demonstrated superior overall results, especially in mixed and dermal melasma, whereas Q-switched Nd:YAG laser was particularly effective for epidermal melasma. Both modalities were well tolerated with minimal adverse effects. Individualized treatment based on melasma type and skin characteristics is essential for optimizing therapeutic outcomes.

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