

Picosecond Lasers and Hypopigmentation: Translating Histologic Insights Into Clinical Caution

We read with great interest the comprehensive review by Lee and colleagues¹ examining histologic and ultrastructural changes after laser and energy-based treatments for pigmentary disorders. The authors synthesize evidence across light microscopy, electron microscopy, reflectance confocal microscopy, and optical coherence tomography, providing clinically relevant mechanistic insights into laser–melanocyte interactions. We wish to highlight several practical implications for patient counselling and risk mitigation during pigment–laser treatments.

Of particular relevance is the review’s discussion of picosecond laser (PSL) technology, which is often perceived as safer than nanosecond devices due to shorter pulse durations and reduced collateral thermal diffusion.² The review notes that PSL treatment of lentigines is associated with smaller vacuoles and less overt structural disruption than Q-switched lasers, a plausible explanation for lower reported rates of postinflammatory hyperpigmentation in some clinical settings. At the same time, the ultrastructural literature summarized in the review highlights an important nuance: preservation of melanocyte structure does not necessarily equate to pigmentary safety under cumulative exposure conditions. This distinction is particularly relevant in melasma, where treatment typically involves repeated low-fluence passes over broad areas, rather than single-pass treatment of discrete lesions such as lentigines.

Across pigment–laser settings, studies have demonstrated preserved melanocyte counts accompanied by reduced melanosome density, dendritic retraction, and impaired melanosome transfer after laser exposure.³ These subcellular changes provide a plausible mechanistic basis for confetti-like hypopigmentation (punctate leukoderma), characterized by pinpoint-to-speckled hypopigmented macules emerging after repeated low-fluence treatments. In this context, melanocyte viability may be preserved despite impaired pigment production or delivery, and disruption of dendritic processes and melanosome transfer to basal keratinocytes offers a plausible explanation for the persistence of focal hypopigmentation. In melasma “laser toning” protocols, such ultrastructural findings are commonly interpreted as melanosome-targeted injury with relative preservation of melanocyte number. However, reports of confetti-like hypopigmentation after aggressive or

cumulative treatment courses suggest functional melanocyte disturbance in the absence of overt melanocyte depletion.⁴

In this context, we recently reported a clinical case series describing persistent hypopigmentation after PSL treatment for melasma, observed in 0.38% of 796 treated patients, with changes persisting at the six-month follow-up.⁵ Patients were predominantly Fitzpatrick skin Types III–VI, treated in an Australian dermatology setting for epidermal, dermal, or mixed melasma using 755-nm and/or 1,064-nm PSL at treatment intervals of 4 to 12 weeks with a range of 2 to 6 sessions per patient. Hypopigmentation was defined clinically as new, well-demarcated focal lightening within treated areas, confirmed on serial standardized photography.

Treatments were delivered using flat or fractional beam profiles with spot sizes of 6 to 8 mm, fluence ranges of 0.4 to 1.0 J/cm², pulse repetition rates of 5 to 10 Hz, and 2 to 4 passes per session, targeting mild delayed erythema or edema without epidermal whitening. Histopathology and electron microscopy demonstrated preserved melanocyte density with markedly reduced melanosome content, supporting melanocyte dysfunction or subcellular injury rather than melanocyte destruction. Repigmentation was not observed at 6 months.

Taken together, the ultrastructural evidence synthesized by Lee and colleagues and emerging real-world clinical observations suggest that cumulative subthreshold injury during pigment–laser treatments may be clinically relevant. Practical contributors may include treatment density and overlap (e.g., repeated passes over the same cutaneous zone within a session), slow hand speed leading to pulse stacking, higher pulse repetition rates, and repeated exposure of the same anatomical sites across sessions. While PSLs are commonly described as predominantly photoacoustic or photomechanical, clinically meaningful photothermal effects may still occur in routine practice, particularly with repeated pulses and cumulative treatments.

These considerations warrant explicit clinical caution in pigment-prone disorders such as melasma and in patients at higher risk of dyspigmentation. A prevailing perception of PSL devices as uniformly “low risk” may inadvertently obscure the importance of conservative technique, careful titration of treatment density, and vigilance for early focal hypopigmentation in melasma.

In summary, PSLs represent an important advancement in laser dermatology. However, the histologic and ultrastructural data reviewed by Lee and colleagues, together with accumulating clinical experience, support a more measured safety narrative that recognizes the potential for melanocyte dysfunction even when overt melanocyte depletion is not

evident. Clear counselling, careful technique, and early recognition of evolving hypopigmentation remain essential to risk mitigation and refinement of treatment protocols.

References

1. Lee MS, Al Janahi S, Dover JS, Kelly KM, et al. Lasers and energy-based devices for treatment of pigmented lesions with histologic and ultrastructural imaging correlation: a systematic review. *Dermatol Surg* 2025. 10.1097/DSS.0000000000004803
2. Negishi K, Akita H, Matsunaga Y. Prospective study of removing solar lentigines in Asians using a novel dual-wavelength and dual-pulse width picosecond laser. *Lasers Surg Med* 2018;50:851–8.
3. Chen CL, Chen CC, Tsai FL, Chen IL, et al. Modulation of melanocyte in melasma patients after picosecond laser treatment. *J Cosmet Dermatol*. 2025;24(1):e16569. doi:10.1111/jocd.16569.
4. Lee YS, Lee YJ, Lee JM, Han TY, et al. The low-fluence Q-Switched Nd:YAG laser treatment for melasma: a systematic review. *Medicina (Kaunas)* 2022;58:936.
5. Hang X, Lim DS. Hypopigmentation following picosecond laser treatment for melasma: a case series. *Lasers Surg Med* 2025;57:777–87.

Xiaozhun Hang, BMedSci (Hons), MBBS, FRACGP*

Davin Sui Lim, MBBS, FACD†

*Mowbray Park Medical and Dermatology, Brisbane, QLD, Australia;

†Cutis Clinic, Indooroopilly, QLD, Australia

The authors have indicated no significant interest with commercial supporters.