16 Maximizing Safety with Ablative Lasers

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Abstract

Lasers are among the most precise and powerful tools available in facial rejuvenation. Through selective photothermolysis, lasers are able to target specific tissue chromophores based on their absorption wavelength (i.e., hemoglobin, water, melanin). Laser technology and safety have evolved significantly since the continuous wave CO_2 laser developed in 1964, which had less control of energy parameters, leading to frequent injury and scarring. The pulsed mode (and subsequent superpulse and ultrapulse lasers) was a significant advance in safety and efficacy. This technology uses electronic shutters to interrupt the continuous wave of energy into pulses, thereby limiting thermal damage. The introduction of the Er:YAG laser in the mid-1990s offered a more selective absorption of water (12–18 x) than CO_2 lasers with less collateral heat injury to surrounding tissues.

Perhaps the most significant modern advance in the safety and efficacy of lasers was the evolution of the fractional laser in 2003. Fractional thermolysis resurfaces microtreatment zones (MTZ) within a target area (typically 20%); maintaining intervening uninjured epidermis and dermis that preserves the skin's barrier function while speeding re-epithelialization.

Keywords: laser, selective photothermolysis, laser resurfacing, ablation, skin resurfacing, fractional laser, CO2 laser, Er, YAG laser

Key Points

- The most common ablative lasers used in facial aesthetics are CO_2 and Er:YAG. Both target water as a chromophore. Er:YAG is more specific (12–18 x), leading to less surrounding heat dissipation and collateral tissue damage.[1,2,3,4,5]
- The goal of ablative lasers is to eliminate or reduce damaged collagen and encourage new collagen formation and remodeling through a combination of tissue vaporization and collagen denaturation secondary to thermal damage.[6,7,8]
- Ablative fractional lasers lead to microthermal zones of injury, with surrounding areas reaching temperatures of 55–62°C. This denatures existing collagen, leading to neocollagenesis, elastogenesis, and remodeling.[1,9,10,11]
- Ablative lasers can be used on patients of all skin types; however, to avoid permanent hypo or hyperpigmentation and scarring, treatment should be avoided or approached with extreme caution in patients with > Fitzpatrick type III skin.[9,10]

16.1 Safety Considerations

- CO_2 Laser (10,600 nm)
- CO_2 lasers have a higher ablation threshold than Erbium lasers, which means that greater thermal heating is required to achieve effect.[9,10]
- Ablation is achieved at 5 J/cm^2 for CO_2 lasers with a residual 70–150 µm area of heating.[9,10]

- Depth of ablation depends on the number of passes, the fluence, the pulse duration, and the amount of cooling time between passes.[1,11]
- As more passes of the CO_2 laser are performed, less water (target chromophore) is present to be vaporized. This leads to additive heat accumulation and increased potential for thermal injury/scarring.
- Clinical endpoint depends on color assessment of tissue (as in chemical peels) rather than dermal bleeding.[1,6,11,12]
- Fractional CO_2 lasers allow for the creation of microthermal zones (MTZ) of pixilated tissue damage to the underlying dermis while leaving epidermal elements intact. This allows for more rapid re-epithelialization and dermal collagen remodeling. Thus, multiple treatments can be achieved with less risk for pigmentation changes. Coverage density ranges from 10 to 60% per pass depending on the area being treated.[3]

16.2 Er:YAG Laser (2950 nm)

- The Er:YAG laser has the same chromophore as CO_2 laser (water) but is more specific, leading to less thermal diffusion and theoretically increased safety.[13,14]
- Ablation is achieved at 0.5 J/cm^2 for Erbium lasers with a 5–20 µm area of residual heating.[13,14]
- Due to less generation of heat compared to CO_2 laser, the Erbium laser does not have the same effect on collagen remodeling/deposition and is not as effective for skin tightening.[2,13,15]
- Erbium lasers have less depth of penetration compared to CO_2 lasers and are often used to treat more superficial areas (i.e., epidermal lesions, actinic damage, dyspigmentation). However, with higher fluence in multiple passes, they can achieve very deep resurfacing depths and cause scarring.
- Clinical endpoint is punctate papillary dermal bleeding and fragmented appearance of dermis. With this particular laser, pulse durations are increased and significant coagulation can be achieved similar to what is typically observed with the CO_2 laser.

16.3 Pertinent Anatomy

- Safe zones for ablative laser resurfacing (fractional or continuous) include areas with thicker dermis and ample perfusion, including central cheeks, forehead, and nose (▶**Fig. 16.1**). Multiple passes may be applied in these areas to achieve optimal results.
- Danger zones include areas with thinner dermis or areas that may have been undermined during surgery (i.e., in a facelift/necklift) and include: neck, upper chest, eyelids, and periorbital areas (▶**Fig. 16.1**)

16.4 Technical Points

- In areas that have thinner dermis or have been undermined, the laser is obliquely oriented to decrease the degree of ablation (▶**Fig. 16.2**). Settings may also be decreased in these areas (by 30–50%) to avoid bulk heating and scarring.

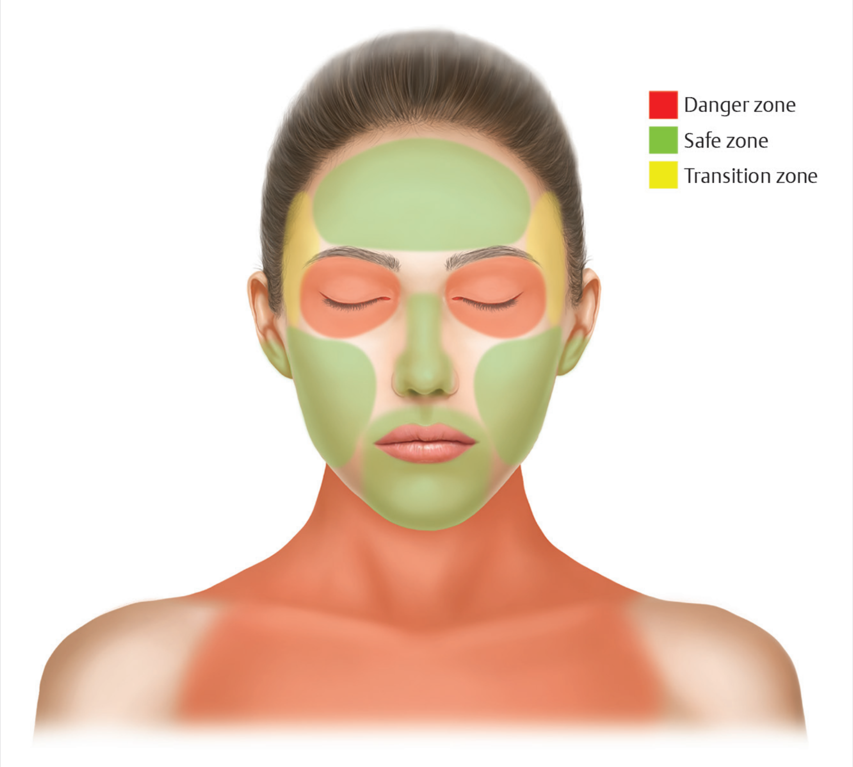

Fig. 16.1 Safe zones and danger zones for ablative laser resurfacing.

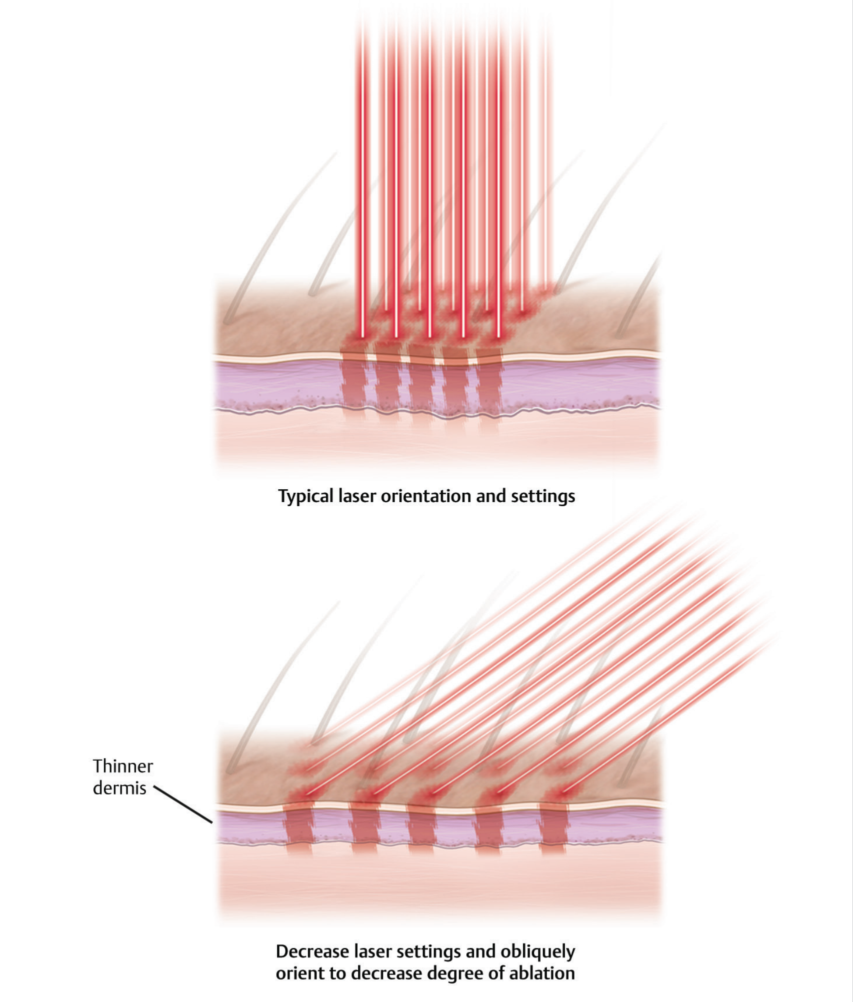

Fig. 16.2 Technique to maximize safety when performing laser after facelift/necklift.

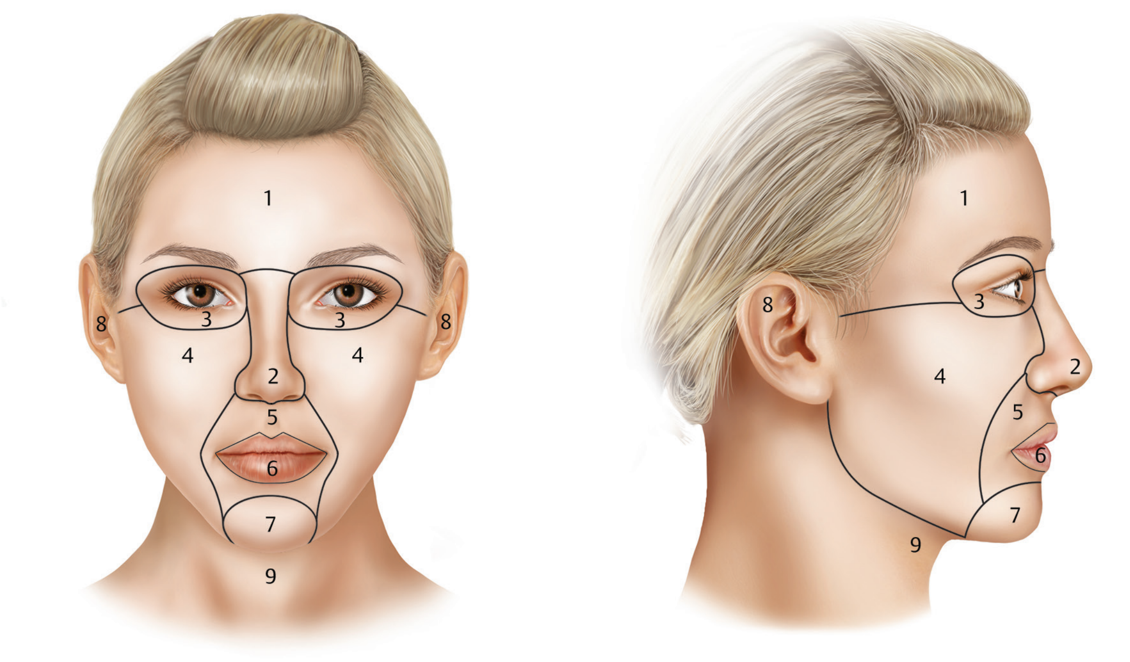

Fig. 16.3 Aesthetic units of the face.

- Aesthetic units are treated and blended with each other to avoid noticeable transition points (▶**Fig. 16.3**).
- The treated areas are assessed continuously until tissue turns white/yellow (CO_2) or petechial papillary dermal bleeding is encountered (Er:YAG) as a clinical endpoint.
- Spot treatment can be utilized to treat peeks of deeper rhytids (typically in the perioral region).

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