# Noninvasive Methods for Lower Facial Rejuvenation

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**KEYWORDS**

• Noninvasive • Nonsurgical • Face • Neck • Rejuvenation • Skin tightening

## KEY POINTS

- Proper patient selection and realistic expectations are key for optimal nonsurgical results.
- Thermal energy is responsible for skin tightening.
- Patients should be treated at the lowest energy able to produce a response.
- All nonsurgical devices carry risk for significant complications.

## INTRODUCTION

Nonsurgical aesthetic medicine continues to be a growing field, with an increase of 22% in the number of nonsurgical procedures performed in 2015.[1] Demand for noninvasive options is increasing because of the popularity of nonsurgical procedures and industry's focus on direct to consumer marketing. The nature of these types of procedures allows for patients to continue to cycle through a practice and may ultimately lead to surgical conversion for some in the future. Such techniques as nonablative and ablative lasers, intense pulsed light (IPL), radiofrequency (RF), high-intensity focused ultrasound (US), and skin care with peeling agents may also be used in conjunction with surgery to optimize the patient's overall aesthetic results.

Each of these technologies relies on a similar principle of thermal disruption of collagen fibers. Collagen is a polymer held together by hydrogen bonds, and it is these cross-links that attribute to the collagen strength. Thermal energy causes a denaturing of the collagen, and the heat-stable intramolecular cross-links are preserved.[2] Skin tightening occurs because of a physical shortening of the collagen fibers with preservation of intramolecular hydrogen bonds, possibly increasing the elastic properties of the skin.[3,4] With increased delivery of thermal energy (ie, increased tissue temperature) there is a greater degree of collagen denaturation and thus resultant tissue tightening. Thermal injury also induces local fibroblasts to produce new collagen as a part of the wound-healing response. Balancing appropriate thermal injury without causing tissue necrosis remains the greatest challenge as the demand for improved efficacy and reproducible treatments rises.

Changes within the collagen occur in a time- and temperature-dependent manner, meaning short exposures to high temperatures or prolonged exposure to lower temperatures create a degree of collagen shortening. Bozec and Odlyha[5] demonstrated that denaturing of collagen fibrils occurs at approximately 65°C, with initial collagen injury occurring around 58°C. Additional studies agree that disruption and denaturing of collagen occurs in the 60°C to 65°C range with a greater degree of denaturation occurring at higher temperatures.[2,3,6,7] It is this initial collagen insult along with the resulting neocollagenesis that triggers the healing response responsible for the observed thermal tightening. However, the burn literature suggests that extensive cell membrane breakdown begins to occur at temperatures greater than 45°C.[8]

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As with any device, the user must understand the parameters of the device not only to optimize outcomes, but also to reduce possible treatment-related complications. Understanding and manipulation of five key parameters allows the user to master the laser device at hand instead of being at the mercy of preset manufacturer protocols. These five parameters for laser devices are[9]

1. Wavelength: determined by the target chromophore and its location within the tissue
2. Power: the amount of energy delivered to the tissue target
3. Spot size: used in correlation with the power to determine the power density
4. Pulse width: the delivery or exposure time of selected energy delivered to the tissue target
5. Cooling: allows for maximal depth of injury without harming more superficial tissue

Only through a complete understanding of the interplay of these five parameters is the user able to adequately treat the target tissue with lasers without unnecessarily damaging collateral tissue in the process. With each subsequent treatment the patient's tissue is uniquely changed and thus presents differently for each subsequent treatment. This leads to a need for slight modifications to the treatment parameters with each procedure.

## LASER AND LIGHT THERAPY

Noninvasive laser devices may be divided into two categories: nonablative and ablative. Both share a similar goal of skin surface changes. When evaluating patients for laser or light therapy, the correct device needs to be chosen to address the specific skin disorder being treated, the target chromophore, and have acceptable downtime (**Table 1**). The most commonly used nonablative, ablative, and light-based devices in our practice are the fractionated 10,600-nm $CO_2$ laser, 2940-nm erbium:yttrium-aluminum-garnet (Er:YAG) laser, full-field Er:YAG, 1064-nm neodymium-doped:yttrium-aluminum-garnet laser, 532-nm potassium titanyl phosphate (KTP) laser, and an IPL device.

**Table 1**
**Choice of devices based on what is being treated and associated downtime**

| | Downtime | |
|---|---|---|
| | **Hours** | **Weeks** |
| Pigment | IPL | Erbium |
| Redness | IPL, YAG (1064), KTP (532) | |
| Wrinkles | Botox, fillers | TCA, Erbium, $FCO_2$ |
| Acne | Fillers | Excision, Erbium, $FCO_2$ |
| Laxity | Ultrasound, RF | Surgery |

*Abbreviations:* KTP, potassium titanyl phosphate; YAG, yttrium-aluminum-garnet.

When using laser and light therapy, there are three main target chromophores within tissue: (1) hemoglobin, (2) melanin, and (3) water. Hemoglobin has three peaks at 400 nm, 532 nm, and 577 to 600, with 577 nm being the most selective for this chromophore. Melanin is found in a wider spectrum between 400 and 1100 nm of light, with the ranges of 400 to 475 nm and 630 to 810 nm being the most selective. Ablative lasers rely on water molecules stored within the tissue target (**Figs. 1** and **2**).

In our hands for skin resurfacing, the full ablative 2940-nm Er:YAG laser has the most dramatic effect on skin resurfacing at the cost of increased down time. The Er:YAG laser has largely replaced the previous generation of $CO_2$ lasers credited to the Er:YAG's precise depth of ablation without the undesirable collateral tissue heating commonly seen with traditional $CO_2$ devices. Total ablative Er:YAG resurfacing has a much more significant recovery than any of the nonablative lasers. However, the Er:YAG is able to provide predictable results with visible end points. This is in part because of the Er:YAG's high absorption by water, which is 13 times greater than that of the $CO_2$ laser. Heating of this water with suprathreshold fluences leads to immediate cellular heating resulting in instant tissue vaporization. A high absorption by water allows for a more precise suprathreshold ablation, with less subthreshold collateral damage to the surrounding tissue. The main downside to the Er:YAG is the prolonged recovery, usually requiring 7 to 10 days for complete re-epithelialization as compared with nonablative modalities. Patients typically have prolonged redness for at least 2 to 3 months post-treatment and it may persist for up to 6 months. This may be shortened by use of IPL vascular treatments to reduce redness after a few weeks postresurfacing.

Fractionated lasers were developed with the hope of achieving an end result similar to the fully ablative $CO_2$ and Er:YAG lasers while allowing the patient a quicker recovery with less down time. Fractionated devices use extremely high fluences to deliver focused columns of energy into the tissue resulting in microthermal zones of injury. Areas surrounding these thermal zones only reach subablative temperatures, yet still undergo significant protein denaturation, tissue coagulation, and apoptosis.[10] The thermal injury sustained generally extends 200 to 300 μm, although it can go