Skin Tightening

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PRACTICE POINTS
- There are a multitude of noninvasive modalities available to treat skin laxity.
- Understanding the mechanisms of each modality is crucial to selecting the appropriate treatment for your patients.
- Treatments should be tailored to the individual patient based on desired outcome, possible adverse events, patient preferences, and cost.

There are many undesirable manifestations that arise as one ages. One of the most notable undesired effects is increasing skin laxity. Traditionally, the gold standard of treatment is surgical correction of skin laxity. However, demand for noninvasive aesthetic procedures has grown due to minimal risk and accelerated recovery time. Over the years, many new devices have become available for addressing skin laxity including laser therapy, radiofrequency (RF), ultrasound, and intense pulsed light (IPL). This article discusses these various noninvasive treatment options and seeks to give providers details of the science behind each device.

Cutis. 2020;106:134-137, 139.

Minimally and noninvasive skin tightening has become one of the most requested cosmetic procedures. Skin laxity often is apparent in areas of the face, neck, jawline, hands, abdomen, and thighs, with features of fine lines, wrinkles, and cellulite. Intrinsic and extrinsic factors contribute to the development of skin laxity. Intrinsic aspects include chronological age, stress, and genetics, whereas extrinsic influences include exposure to solar radiation, environmental toxins, and smoking.[1,2] These factors affect the production and maintenance of both collagen and elastic proteins, which are the main components that help the skin stay firm and smooth. With a goal of improving skin laxity, multiple skin tightening modalities have been developed.

Traditionally, skin laxity was treated by invasive surgical skin procedures (eg, rhytidectomy), which carry a high financial cost, require an operating room and general anesthesia, have a prolonged recovery time with notable postoperative care, and have possible risk of unwanted scars.[3,4] The risks associated with invasive procedures have spurred a growing demand for minimally invasive and noninvasive methods, which have fostered the development of several skin laxity reversal modalities over the last decade. Although the achieved results of these technologies are less dramatic and require more treatments, they do not possess the associated risks and adverse effects seen in invasive surgical procedures. As such, demand for these techniques has been growing among cosmetic patients.

There are multiple technologies that currently are employed to achieve noninvasive skin tightening. Laser therapy, radiofrequency (RF), ultrasound, and intense pulsed light (IPL) are methods that focus targeted energy to elevate temperatures in the deeper layers of the skin. Elevated thermal energy causes denaturing of collagen with preservation of heat-stable intermolecular cross-links. Skin tightening is achieved through physical shortening of the collagen fibers with preservation of the heat-stable intermolecular hydrogen bonds, which leads to an increase in the rubber elastic properties of the collagen polymer and stimulation of new collagen formation.[5,6] The temperature at which this process occurs has been frequently reported as approximately 65°C.[7,8] Alternative noninvasive therapies that do not focus on elevated thermal energy for skin tightening include chemical peels and skin care products.

Given the multitude of treatment methods that have been developed to counteract skin laxity, this article seeks to provide an overview of some technologies, devices, and

commonly used therapies to help dermatologists choose the appropriate modalities for their cosmetic patients.

Laser Therapy

Since its approval in the 1980s, laser therapy has become an alternative to invasive surgical skin tightening.[9] Laser therapy utilized for treatment can be subcategorized into 2 types: ablative and nonablative.

Traditional ablative skin tightening utilized CO_2 or erbium:YAG lasers. These lasers caused skin tightening by first ablating the epidermis cleanly off the dermis, with a partially coagulated area in the dermis, which triggered a wound-healing cascade followed by neocollagenesis and remodeling.[10,11] Although this treatment displays notable retightening of the skin, traditional ablative lasers are not routinely used, likely because of lengthy recovery periods, risk for scar development, flares of acne and herpes simplex virus, hyperpigmentation, and delayed-onset hypopigmentation.[9,12,13]

Fractional ablative laser treatments soon emerged as an effective alternative to traditional ablative lasers. Various studies have noted better recovery times and side-effect profiles.[14-18] This improvement is believed to be due to the method of wound healing in fractional ablative laser treatments. Ablative fractional photothermolysis works by generating deeply narrow focal ablations that involve the dermis and epidermis while leaving the surrounding skin unscathed, which allows for rapid re-epithelization, filling in of the dermal pockets, and stimulation of dermal remodeling.[10,11,18,19] Studies have demonstrated a range of improvement in skin laxity from 56% to 65.3% at 6 months posttreatment.[20,21] Although the incidence of reported side effects is better than with the traditional ablative laser, fractional ablative lasers have documented reports of similar types of side effects as traditional lasers due in part to ablation of the skin.[22,23]

Nonablative lasers were developed as alternatives to ablative laser treatments. This class of lasers produces a milder effect compared with its ablative counterpart. Studies show a quantitative improvement range of 8.9% to 11% in skin laxity 3 months posttreatment.[24,25] Nonablative lasers induce controlled tissue injury in the dermis, which leads to stimulation of dermal remodeling and collagen production.[11] Although the effects of nonablative lasers are milder compared with their ablative counterparts, they possess the superior benefit of minimal adverse events. Most studies reported transient erythema posttreatment, but no long-term adverse effects have been noted,[26-31] in part due to preservation of the epidermal layer.

Radiofrequency

Radiofrequency technology was the first method marketed for noninvasive skin tightening. Radiofrequency devices work by generating heat through tissue resistance to an applied alternating electrical current, which leads to collagen contraction and remodeling along with neocollgenesis.[32] The major electrode configurations used in these technologies are monopolar, bipolar, and multipolar, which differ by the electric field they produce. Reported side effects include erythema that arose 1 week following completion of treatment and resolved by 6-month follow-up, as well as hypertrophic scarring, transient postinflammatory hyperpigmentation, and pain.[33,34]

Monopolar systems were the first among these devices to be developed for use in skin tightening and remain the most extensively studied technology for treatment of skin laxity. Developed in 2001, the Thermage device (Solta Medical, Valent Pharmaceuticals) remains the most extensively studied technology for the treatment of skin laxity.[35] In a trial performed by Fitzpatrick et al,[36] treatment of skin laxity of the periorbital area with ThermaCool TC (Thermage, Inc) demonstrated an 83.2% improvement in at least 1 point treated and an overall 28.9% improvement of the entire treatment area at 6-month follow-up. Additionally, a survey study of 5700 patients who received monopolar RF skin tightening treatments demonstrated that 26% of patients experienced immediate tightening following treatment, and 54% observed tightening 6 months posttreatment.[37]

Bipolar and multipolar devices were developed following the success of monopolar devices in the treatment for skin laxity. In a study evaluating multipolar RF for the face and neck, all 11 patients were determined to have improvement of their skin laxity following weekly treatments for 8 weeks.[38]

Ultrasound

The use of ultrasound for skin tightening was first approved in 2009.[39] The primary mechanism of skin tightening is through thermally induced contraction of collagen with subsequent collagen neogenesis achieved through absorption of the vibrational acoustic energy into target tissue.[40] There are 2 types of ultrasound methods: microfocused and high-intensity focused. Microfocused ultrasound focuses on delivering lower-energy pulses to the deep reticular dermal and subdermal layers that lead to disruption of the underlying architecture of the skin, promoting increases in distensibility, elasticity, and viscoelasticity.[41] To date, microfocused ultrasound is approved for treating skin laxity of the eyebrow and submental area and wrinkles of the décolleté. Currently, there are 2 devices approved by the US Food and Drug Administration for the treatment of skin laxity with ultrasound. These devices are the Ulthera System (Merz Pharmaceuticals) and the Sofwave system (Sofwave Medical Ltd).[42] Oni et al[43] evaluated 93 patients following treatment using Ulthera for skin laxity in the lower face. There was a noticeable improvement of 63.6% at 90 days following treatment. Brobst et al[44] showed improvement in laxity at 6 months and 1.5 years following last treatment. The most commonly reported posttreatment side effects include transient purpura, transient edema, and transient postinflammatory pigmentation.[42,45] Serious complications are

rare and include development of palpable subcutaneous nodules and motor nerve paresis.[42,46]

High-intensity focused ultrasound has been more recently introduced as a modality for skin tightening and rejuvenation. This method focuses on applying heat to areas through acoustic energy to areas of the deep dermis, subdermal connective tissue, and fibromuscular layer in targeted microcoagulation zones without effect to the epidermis.[47] The targeted thermal effects and microcoagulation are believed to cause skin tightening through collagen contraction and remodeling. Future studies are needed to determine the overall benefits in skin laxity to achieve approval by the US Food and Drug Administration for use as a treatment option.

IPL Therapy

Intense pulsed light therapy is different from lasers in that it utilizes a wider variety of wavelengths ranging from approximately 500 to 1200 nm.[48] The process of skin tightening is achieved through selective photothermolysis in which thermal damage is focused solely on pigmented targets at the cellular or tissue levels in the epidermis and dermis.[49] Intense pulsed light penetrates the tissues and is selectively absorbed by melanin and hemoglobin, thereby producing photothermal effects. The photothermal effects lead to reversible thermal damage to surrounding collagen and induction contraction of collagen fibers and fiber remodeling.[50] Clinical studies on the effectiveness on skin tightening have shown incongruent results. Multiple studies have noted improvement in skin elasticity as well as increased deposits of collagen in treated areas. Other studies have shown no improvement of rhytides or wrinkle reduction. The side effects noted were transient pain, swelling, and erythema, along with rare instances of blisters and crusting.[48,51-54] Due to the inhomogeneous results, the use of IPL is largely reserved for treatment of acne, hyperpigmentation, hypertrichosis, and superficial vascular malformations.

Chemical Peels

Chemical peels are used in the treatment of skin laxity through a process similar to ablative lasers. Unlike other methods described in this article, this type of treatment is only reserved for the facial areas. The peel must penetrate to the lower papillary dermis or deeper to allow for adequate collagen synthesis.[55] As such, medium to deep peeling agents should be used.[56] Peels cause coagulation of membrane proteins and necrosis of the epidermis and dermis, thereby stimulating collagen synthesis and keratinocyte regeneration. Additionally, there is an increase in the deposition of glycosaminoglycans, which play a major role in providing hydration for the skin because of their water-binding capacity.[56] Deep peels have the added effect of restoring dermal architecture to its native state. Medium-depth peels work up to the layer of the epidermis and dermis.[57] Trichloroacetic acid (TCA) 35% is the main ingredient used in these types of peels. Some examples include Monet combination (Jessner solution with 35% TCA), Brody combination (solid CO_2 plus 35% TCA), and Coleman combination (70% glycolic acid and 35% TCA). Deep peels penetrate to the levels of the reticular dermis.[58] The formulation of these peels contain croton oil and phenols in various concentrations.[57,58] A study by Brody[59] noted clinical improvement of skin laxity–attributed histologic depth achieved by medium-depth peels. The results of the study demonstrated that the depth of wounding from 3 consecutive applications of TCA led to greater epidermal hyperplasia and a more dense formation of dermal elastic fiber formation on histologic examination. Side effects noted in the study included transient erythema, edema, and erosions that resolved without scar formation at 30-day follow-up.[59] Another study performed by Oresajo et al[60] demonstrated that patients treated with either a chemical peel of 41% capryloyl salicylic acid or 30% glycolic acid led to notable reduction of fine lines/wrinkles vs baseline. Side effects noted included pruritus, erythema, increased skin sensitivity, epidermolysis, allergic and irritant contact dermatitis, and postinflammatory hyperpigmentation.[60]

Skin Care

Skin care products have been developed over the years and marketed to aid in the treatment of skin laxity. Some studied methods include photoprotection products, antioxidant-based products, and vitamin A products. Photoprotection plays a crucial role in the prevention of skin laxity. Unprotected sun exposure can induce damage to previously treated skin, leading to minimized or cancelled rejuvenation measures.[61]

Oxidation is a major contributor in the development of skin laxity. The skin naturally possesses endogenous antioxidant defense mechanisms that protect its cells from free radical damage. However, these mechanisms are reduced as skin ages and are further diminished with photodamage. Ascorbic acid is a collagen stimulator that is known to have antioxidant properties. In the appropriate formulations, topical vitamin C directly supplements the skin's antioxidant reservoir.[61]

The use of vitamin A, a retinoic acid, for treatment of skin laxity is based on its ability to improve the production of procollagen and elastic fiber components, resulting in the restoration of dermal matrix proteins.[61-65] Vitamin A in the skin plays a key role in the regulation and control of proliferation and differentiation of all major cell types found in the epidermis and dermis.[61] Studies have shown that the long-term use of topical vitamin A improves fine and coarse wrinkling.[65]

Final Thoughts

Various technologies have been developed to provide clinically significant skin laxity reversal. Laser, RF, ultrasound, IPL, and topical therapies provide numerous options at our disposal. Although many devices are available, it is important to consider the desired outcome, cost, and adverse

events when discussing therapeutic options for treating skin laxity (eTable). Patients should be advised that multiple treatment sessions over the course of months will likely be necessary. With the development of numerous technologies, we now have many options to offer our patients who desire minimally or noninvasive skin tightening.

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APPENDIX

eTABLE. Factors to Consider When Evaluating Treatments for Skin Laxity

Treatment	General Cost,[66,a] $	Efficacy	Frequency of Treatments	Healing Time	Potential Side Effects
Laser therapy[20,24]	Ablative: 1963; nonablative: 1201	Ablative: 56%–65.3% at 6 mo posttreatment; nonablative: 8.9%–11% in skin laxity 3 mo posttreatment	Ablative: single treatment; nonablative: 3 full-face treatments 4–6 wk apart	Ablative: 1–10 d following last treatment; nonablative: minimal	Ablative: hyperpigmentation, erythema, edema, acne, infection, scarring; nonablative: transient erythema, transient edema, transient PIH, herpes reactivation
Radiofrequency[36]	2134	28.9%–54% improvement of the entire treatment area at 6-mo follow-up	Single treatment pass	No recovery time	Erythema, edema, blistering, bruising, burns, skin indentations, subcutaneous fat loss, permanent scarring, changes to pigmentation, open sores, and infections
Ultrasound[43]	2134	63.6% at 90 d posttreatment	Single treatment with double passes over targeted areas	No recovery time	Transient purpura, transient edema, transient PIH; serious complications are rare and include development of palpable subcutaneous nodules and motor nerve paresis
Intense pulsed light therapy[51-54]	406	Incongruent results	4–6 treatments at 3-wk intervals	No recovery time	Transient pain, swelling, and erythema, along with rare instances of blisters and crusting
Chemical peels[60]	644 per treatment session	41% of caproyloyl salicylic acid–treated and 30% of glycolic acid–treated patients demonstrated notable reduction of fine lines/wrinkles vs baseline	Biweekly product application of either of 2 peels for 12 wk	1–7 d (varies with depth of peel)	Pruritus, erythema, increased skin sensitivity, epidermolysis, allergic and irritant contact dermatitis, PIH
Skin care	Variable, depending on products	Prevention of laxity development	Daily application	None	Adverse allergic reactions

Abbreviation: PIH, postinflammatory hyperpigmentation.
[a]Varies with treatment area, geographic location, and physician practice.