Ultrasound Skin Tightening

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KEYWORDS

• Skin tightening • Skin lifting • Photo-rejuvenation • Ultrasound • Photoaging

KEY POINTS

- Skin laxity is a common sign of photoaging.
- Skin lifting and tightening is a desirable outcome by a most patients interesting in photorejuvenation.
- Noninvasive treatment options for skin tightening and skin lifting are limited.
- Intense focused ultrasound has been shown to provide skin lifting and tightening, making it the only device approved by the Food and Drug Administration for this indication.
- Ultrasound is a safe and efficacious treatment for mild skin tightening and lifting.

INTRODUCTION

Photoaging of the face occurs in a semipredictable stepwise progression that includes both textural and pigmentary alterations to the skin. In the initial steps of skin aging, dynamic rhytides are evident in areas of skin movement; these eventuate into static rhytides. With further age, the skin, both facial as well as areas off the face, begin to develop laxity, which is often most evident in the jowls and submental skin. Photorejuvenation of the skin, in its optimum, should therefore address all of these components of the aging skin. Traditionally, various energy-delivery devices were used to treat several components of skin aging, including rhytides, laxity, and dyschromia, such as ablative carbon dioxide or erbium:yttrium-aluminum-garnet devices, as well as treatments such as deep chemical peels and dermabrasion. These methods relied on ablation of the epidermis causing reepithelialization while delivering significant thermal injury to the dermis sufficient to stimulate a robust wound-healing response with subsequent collagen remodeling and contraction leading to decreased rhytides, improvement in skin texture, skin tightening, and improvement in pigmentation. However, despite significant improvement in these skin characteristics and efficacy of these treatments, significant patient downtime, long and painful posttreatment healing, and substantial side effects were major drawbacks of these ablative procedures.

In recent years, multiple different treatment modalities have become available for treatment of skin wrinkling and laxity in a nonablative manner. These include lasers and light devices, infrared energy devices, and energy-based procedures, including radiofrequency ablation. These allow the use of thermal energy to target the reticular dermis and subcutis in an effort to cause tissue contraction and dermal remodeling while minimizing undesirable epidermal injury. As a result, "downtime" is minimized with expedient postprocedure healing, allowing for the patient to proceed with regular activities shortly after treatment, minimizing the necessity to interrupt a busy patient's work or social schedule. Additionally, minimal epidermal injury allows for safer

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treatment among a wider range of skin types and reduces the risk of adverse events compared with either ablative resurfacing or more invasive surgical procedures, such as rhytidectomy. However, the drawback of these safer nonablative methods are that, relative to their invasive and ablative counterparts, the results are often modest, less reliable, and inconsistent duration of benefit. Individual variation in responsiveness to noninvasive skin tightening has also been significant. Ultrasound is an energy modality that can be focused and penetrates deeper in the tissue to cause thermal coagulation. Intense focused ultrasound (IFUS) for skin rejuvenation has been shown in recent studies to be safe and effective for skin tightening and lifting.

Ulthera System (Ulthera Inc, Mesa, AZ) is an IFUS device that delivers inducible energy to selected foci within the dermis and subcutis leading to the generation of heat and selective coagulative changes. The generated heat causes initiation of the tissue repair cascade in which the end result is a tightening effect of the skin. Results from several studies have led Ulthera to receive the first and only Food and Drug Administration approval for skin lifting, initially for eyebrow lifting in 2009, followed several years later with an approval for skin lifting of the neck and submentum. A unique added advantage to the use of ultrasound for skin rejuvenation is the direct visualization of the dermis and subcutaneous structures before treatment, which adds an extra level of safety to the treatment. Unfocused ultrasound energy can be used to image the treatment area while focused ultrasound energy can induce thermal injury of the mid to deep reticular dermis without damaging more superficial layers. Direct visualization allows for the identification of key anatomic structures and their depths and adapting the energy deposition to deliberate and precise locations in the dermis or subcutis. The device is particularly efficacious for treatment of patients with moderate laxity of the skin on the face for "lifting" of the eyebrow, neck, and submentum; however, recently it also has been used in various other locations and applications, including tightening of the skin of the buttock, décolleté, and other locations on the face, as well as for the treatment of acne and hyperhidrosis.

DEVICE PROPERTIES/TECHNOLOGY

Ultrasound is the sound wave frequencies above the range of human hearing (18–20 kHz). Ulthera operates at 4 to 7 MHz. The ultrasound imaging is adapted to the visualization of the first 8 mm of tissue, thus specifically allowing for imaging of skin. The dual-modality ultrasound combines the capability of real-time imaging allowing visualizing below the skin's surface and providing precisely placed "thermal coagulation points" (TCPs) at prescribed depths. This creates small microcoagulation zones of 1 mm^3 to 1.5 mm^3, which cause thermal contraction of tissue. The subsequent wound-healing response results in collagen stimulation.

Ulthera Device

The Ulthera device consists of a central power unit, a computer, and interchangeable delivery handpieces. The same handpiece contains a transducer that enables sequential imaging (lower-energy ultrasound, allowing visualization of dermal and subcutaneous structures) and treatment (delivery of higher-energy ultrasound exposures). Multiple source settings can be controlled, including power output, exposure time, length of exposure line, distance between exposure zones, and time delay after each exposure.

The device initially had 3 handpieces:

1. Superficial: 7.5 MHz, 3.0-mm focus depth
2. Intermediate: 7.5 MHz, 4.5-mm focus depth
3. Deep: 4.4 MHz, 4.5-mm focus depth

Most recently, a 19-MHz transducer capable of producing focal TCPs at depths of 1.5 mm into the dermis was introduced to cause more superficial dermal neocollagenesis.

Human cadaveric tissues have demonstrated that penetration depth is determined by frequency, such that higher-frequency waves produce a shallow focal injury zone and lower-frequency waves have a greater depth of penetration to produce TCPs at deeper layers.[1]

Each probe delivers the energy in a straight 25-mm line with TCPs 0.5 to 5.0 mm apart at a given depth within the tissue. Short pulse durations (25–50 ms) and relatively low energy (in the 0.4–1.2 J range), depending on the particular transducer, confine the TCPs to their target depth. The handpiece moves in a straight line at the set conditions (power, duration) and at the selective variables (length of treatment, spacing of exposures) to produce uniform tissue exposures for each "line" of IFUS treatment. Human cadaveric studies, as well as preclinical studies in porcine skin and prerhytidectomy excision skin have confirmed consistency in the depth, size, and orientation of TCP created by IFUS, in the subdermal soft tissue and deeper superficial musculoaponeurotic system (SMAS) layers, while preserving immediately adjacent soft tissue and structures.[2–5]