Procedural Options for Aging

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Patients want to look as good as they feel. As the skin undergoes changes from intrinsic and extrinsic aging, its appearance and condition do not always match how the patient feels; however, there are a variety of options for noninvasive procedures that can restore a youthful and refreshed appearance to the skin. Rhytides, volume loss, actinic damage, and photodamage can be improved with a combination of neurotoxins, soft tissue fillers, photodynamic therapy, tightening devices, and resurfacing devices, depending on the patient's specific cosmetic needs.
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As the skin undergoes changes from intrinsic and extrinsic aging, its appearance and condition do not always match how the patient feels. Fortunately, there are a variety of noninvasive procedures to treat the rhytides, volume loss, actinic damage, and photodamage commonly associated with aging.

AGING SKIN

Photoaging refers to the changes that occur when the skin has been exposed to excessive UV radiation.[1] These changes can include tactile roughness, dyschromia, course texture, rhytides, telangiectases, and precancerous and cancerous growths. Photodamaged skin has compromised integrity and is susceptible to accelerated loss in facial volume from fat loss and skeletal changes. These clinical changes also correlate with histologic changes, including thinning of the epidermis, flattening of the dermoepidermal junction, disorganized and fragmented collagen fibrils in the dermis, and replacement of normal collagen in the dermis with amorphous elastin material. Intrinsic aging leads to a decrease in type I and type II collagen in the skin, which is accelerated in sun-damaged skin. Fibroblasts in photodamaged skin are elongated, collapsed, and more numerous, yet when fibroblasts from sun-damaged skin are cultured, they are still able to produce the same amount of collagen as fibroblasts from non–sun-damaged skin. The reduction in collagen occurs because the surrounding fragmented collagen fibrils do not place any mechanical tension on the fibroblast to stimulate normal function, not because the fibroblasts are unable to produce collagen. UV radiation decreases messenger RNA expression and produces free radicals that negatively affect fibroblasts and keratinocytes, resulting in DNA damage, inhibition of protein tyrosine phosphatases, and upregulation of activator protein 1 and nuclear factor κB. There also is an increase in proinflammatory cytokines, including IL-1β, tumor necrosis factor α, IL-6, and IL-8, as well as matrix metalloproteinases, which cause inflammation and degradation of collagen. In summary, UV radiation decreases collagen production and increases collagen breakdown.[1]

There are a variety of procedural options that can improve the signs of aging. For example, neurotoxins soften expression lines and improve the shape of the face. Soft tissue fillers can restore youthful volume and facial shape. Adding volume to the skin with fillers such as hyaluronic acid also increases collagen content by applying mechanical tension to fibroblasts. Photodynamic therapy (PDT) reduces cancerous and precancerous growths as well as skin texture. Radiofrequency and infrared light devices tighten the skin, and laser resurfacing eliminates dyschromia and wrinkles, improves texture, reduces pore size, and reduces the number of existing precancerous

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growths and decreases the incidence of new growths. These treatment options can be used in combination to achieve the best cosmetic outcome for the patient.[1,2]

NEUROTOXINS AND SOFT TISSUE FILLERS

Botulinum toxin type A was approved by the US Food and Drug Administration for cosmetic use in 2002. It prevents the release of acetylcholine from the presynaptic neuron so the targeted facial muscle does not contract. Dynamic lines are caused by repeated contraction of the muscle, which creates a crease in the skin. With time, these creases become lines at rest. Botulinum toxin is a preventative procedure, as it not only softens the lines but also will prevent the dynamic lines from becoming lines at rest. Botulinum toxin type A also helps to improve the shape of the face. It can elevate the brow, lift the corners of the mouth, enhance lip definition, soften platysmal bands, and improve the contour of the jawline with the Nefertiti lift.[3] This procedure improves not only the patient's physical appearance but his/her psychological state as well, as demonstrated by Dayan et al.[4,5] Additionally, first impressions of the patient as well as the patient's perception of his/her quality of life also are known to improve after botulinum toxin type A treatment of the upper face. The improvement in first impressions of the patient likely is due to an improved appearance, which results in better treatment from others[4]; patients also may feel they look better, which increases their self-esteem and confidence, ultimately improving their quality of life.[5]

With time, people lose fat and bone in the face, which leads to an aged appearance. This volume change becomes evident in individuals older than 50 years. Soft tissue fillers are helpful in restoring a more youthful appearance. Fillers are most effective when used to replace lost volume in the cheeks and temples and to lift the face, rather than filling individual wrinkles.[6]

Two studies in particular highlight the correlation between facial volume and perception of age and attractiveness. A 2010 study by Dayan et al[6] reported that hyaluronic acid injections in the nasolabial folds improves first impressions. In 2009, a study conducted by Guyuron et al[7] supported the correlation between facial volume and the perception of a youthful appearance. Participants in this study were identical twins who filled out detailed surveys about sun exposure, environmental and occupational exposures, and body weight. Participants also were photographed. Evaluators then analyzed facial features, degree of photodamage, perceived age, and other factors. Findings pertaining to facial volume in identical twins 55 years and older showed that higher body mass index was associated with a younger appearance. Because volume changes become apparent around 50 years of age, the heavier twins had more facial fat and therefore looked younger.[7]

During the aging process, the shape of the face also changes. Skeletal changes and fat loss cause the soft tissue of the face to move both anteriorly and inferiorly. Superficial and deep compartments of facial fat act independently of each other and the replacement of volume in deep fat compartments restores the anterior projection of the cheek.[8-10] Skeletal changes in the face are explained by Lambros's[11] theory, which describes the changes in the midfacial skeleton as a clockwise rotation of the midface relative to the cranial base. As the skeleton rotates forward, the support of the soft tissue changes and the soft tissue moves anteriorly and inferiorly, which leads to a more rectangular shape of the face.[11] Pessa[12] compared computed tomographic scans of younger men (mean age, 21 years) versus older men (mean age, 56 years) and compared 4 angles of the midfacial skeleton to see if the findings supported Lambros's theory. He found a significant decrease in the maxillary and pyriform angles with increased age ($P=.005$ and $P=.004$, respectively), which supports the finding that the midfacial skeleton rotates forward, leading to a lack of support for soft tissue.[12] Soft tissue fillers are used to reshape the face with more focus on filling deeper compartments to add support and lift the soft tissue. For example, instead of only filling the nasolabial folds, a more global approach is taken to add volume to the cheeks, preauricular area, jawline, and chin according to the patient's needs. Not only do fillers add volume and support, but they also add mechanical tension to fibroblasts, thus stimulating collagen formation, which improves skin texture and facial volume.[13]

PHOTODYNAMIC THERAPY

Photodynamic therapy is an effective treatment of actinic keratoses and nonmelanoma skin cancers and also is a therapy for photoaging. This treatment reduces fine lines, actinic damage, and dyschromia by increasing collagen content and decreasing elastotic material in the dermis. The mechanism of action is unknown, but it is thought to be an inflammatory, molecular, or immune response. Several researchers noted improvement in photoaging when treating actinic keratoses with PDT. Avram and Goldman[14] showed improvement in the signs of photoaging in patients treated with aminolevulinic acid (ALA) PDT with intense pulsed light (IPL). In 2002, Gold[15] noted that patients treated with ALA plus blue light PDT had 83% fewer actinic keratoses and improvement in photoaging. Ruiz-Rodriguez et al[16] also found that patients experienced a decrease in actinic keratoses after 2 treatments with ALA PDT as well as improvement in texture and pigmentation. Split-face studies were conducted to compare ALA and light source (pulsed dye laser or IPL) to light source alone (pulsed dye laser or IPL). These studies showed more rejuvenation in the half of the face pretreated with ALA.[17] Marmur et al[18] found that there was an increase in collagen production after ALA PDT with IPL versus IPL alone. Issa et al[19] studied 14 participants who underwent 2 treatment sessions of methyl aminolevulinate with red light and histologic evaluation showed an increase in collagen fibers and decrease in elastic fibers at 3 and 6 months postprocedure. The clinical findings showed improvement in texture, firmness, wrinkle depth, skin discoloration, and actinic keratoses.[19] Zane et al[20] reported similar results from a study of 20 participants who underwent 2 treatment sessions of ALA PDT with red light. Not only did the clinical signs of photoaging improve, but the echogram of skin biopsies showed an improvement in skin thickness and a reduction of the subepidermal low-echogenic band thickness. The thickness of the subepidermal low-echogenic band is directly related to the amount of elastotic material in the dermis.[17,19,20]

RADIOFREQUENCY AND INFRARED LIGHT DEVICES

Skin laxity is a part of the aging process but is not limited to photoaging. It is the result of a loss of collagen as well as gravitational forces. Tightening devices emit either radiofrequency or infrared light between 1100 and 1800 nm and are nonsurgical methods of modestly improving skin laxity. These technologies help redefine the jawline and minimize the appearance of jowls. Nonablative tightening devices can lift the face and enhance cheek and jawline definition. They also can be used to tighten eyelids and loose skin on other areas of the body, such as the abdomen, arms, or thighs. Based on anecdotal experience, these procedures typically are safe with no downtime. It is important to make sure that the patient has appropriate expectations regarding cosmetic outcome. A face-lift is the gold standard for addressing skin laxity; however, not all patients want to undergo surgery or the downtime and risks that are involved. Radiofrequency and infrared light devices will not provide improvement at the surgical level but are options for the patient who does not want surgery and will be satisfied with a more natural subtle improvement. Based on anecdotal experience, these modalities are safe for use on all areas of the body and in all skin types.

Infrared tightening devices emit infrared light that is absorbed by water in the dermis and causes thermal damage, resulting in a tightening effect. Radiofrequency devices create an electrical current in the tissue, and as the current travels through the tissue, it meets the natural resistance of the dermal tissue and generates heat. This process results in thermal damage in the dermis, thereby promoting skin tightening. There is an immediate tightening effect of the tissue as well as gradual tightening that occurs over 4 to 6 months. The immediate tightening is due to the disruption of the hydrogen bonds in the collagen triple-helix molecule, which causes contraction of the collagen. The wound-healing response occurs over several months, resulting in a thicker remodeled dermis. There also is selective heating of the fibrous septae in the subcutaneous tissue. The electrical current travels the path of least resistance; there is less resistance in fibrous septae than in fat, which is why the risk for fat necrosis is minimal with this treatment.

The most common types of radiofrequency devices are monopolar and bipolar devices. Monopolar devices utilize a single electrode to pass an electrical current to a grounding pad. A bipolar device passes the electrical current between 2 identical electrodes positioned on the skin. Electro-optical synergy devices utilize light (900 nm) to preheat the dermis prior to bipolar radiofrequency, which changes the impedance so that less radiofrequency energy is needed for tightening. The safety profile of this device is high, but there have been reports of superficial burns due to incomplete electrode contact with the skin and too little coupling fluid, transient erythema and edema, temporary numbness of skin innervated by the greater auricular nerve, and fat atrophy. These side effects are less likely when multiple passes at lower energies are used rather than fewer passes at higher energies.[21]

A newer tightening procedure is called fractional radiofrequency, which is similar to fractional photothermolysis in that zones of thermal damage are created to stimulate intense wound healing; however, this technology utilizes radio waves, not infrared light. Bipolar electrode pairs are inserted directly into the reticular dermis and the tissue is heated to an exact temperature for a specific amount of time. This process is repeated until the desired treatment area has been adequately covered. The device creates zones of thermal damage (tissue between the bipolar electrodes) surrounded by untreated dermis, which results in vigorous wound healing. A study by Hantash[22] demonstrated the histologic changes produced by radiofrequency. Twenty-two participants were scheduled for abdominoplasty and the skin that was to be surgically removed received 5 treatments with the fractional radiofrequency device at 10 weeks, 28 days, 14 days, and 2 days before the procedure, and immediately preceding surgery. After the surgery, biopsies were performed at all time points and evaluated by reverse transcription–polymerase chain reaction and immunohistochemistry. This study showed evidence of neoelastogenesis from radiofrequency treatment in human skin. Other findings included an increase in reticular dermal volume; an increase in hyaluronic acid and elastin; and induction of tropoelastin, fibrillin, and type I and type III procollagen.[22]

To enhance the tightening effect, radiofrequency and tumescent liposculpture of the neck can be combined. Liposculpture of the chin, jowls, neck, and submental areas removes excess adipose tissue; during the healing process, the skin is redraped and tightened. Liposculpture should be performed first, and if more tightening is desired, radiofrequency treatments can be administered 1 month following the initial procedure. Radiofrequency tightening devices should be repeated annually for best results.

LASER RESURFACING

Laser resurfacing is the most effective and reproducible way to reverse photoaging. It eliminates dyschromia and wrinkles; improves texture; reduces pore size; and improves striae, acne scars, and surgical scars. The gold standard for laser resurfacing was the CO_2 laser. It peels 100% of the epidermis and requires 2 weeks for the skin to reepithelialize. The procedure requires quite a bit of clinical downtime with laborious wound care. Because the skin barrier is compromised for 2 weeks, there is risk for infection, scarring, and pigmentary alteration. Also, traditional CO_2 resurfacing is only safe for lighter skin types. Treatment of the face is dangerous, and the procedure requires general anesthesia in most cases.

Fractional photothermolysis was developed in 2004 as a method of nonablative resurfacing with consistent and remarkable results. Because this modality is nonablative, also known as nonablative fractional resurfacing (NFR), the safety profile is greatly improved and the downtime consists of erythema and edema of intact skin, as opposed to an ablative device, which deepithelializes the tissue for up to 2 weeks. This device creates zones of thermal damage in the tissue (1000–2000 cm^2) that can penetrate 1.4 mm into the tissue. Millions of microscopic thermal zones are created and each zone is surrounded by untreated tissue; thus this device treats a fraction of the skin during each treatment and usually requires 4 treatments. Thermal damage promotes wound healing, and within 24 hours, new keratinocytes repair the epidermis and the necrotic epidermis is shed in 7 days. The microscopic thermal zone is completely repaired in 3 months without fibrosis. The percentage of surface coverage and the depth of thermal damage are determined by the physician according to patient needs. For example, melasma and actinic keratoses are more effectively treated with superficial penetration with more surface area coverage, whereas wrinkles, acne scars, and striae respond better to deeper treatments. Laubach et al[23] demonstrated the impressive wound healing response with NFR. Twelve study participants were treated once on the forearm with the fractional resurfacing laser. The skin was biopsied and evaluated over 3 months. Results indicated that the basal layer of the epidermis was repaired within 24 hours and complete epidermal repair occurred by day 7. The necrotic epidermis slowly moved to the skin surface as the new epidermis formed beneath it. The necrotic epidermis was shed by day 7 and acted as a biological barrier until it was shed. Therefore, the skin surface was always intact. Type III procollagen staining increased at day 7 and heat shock protein 70 increased 1 day after treatment, both important for wound healing. There also was an increase in smooth muscle actin 1 day after treatment, which was important in wound contraction and tightening. No fibrosis was noted.[23]

Nonablative fractional resurfacing is safe for all skin types and body areas. One particular NFR laser, the Fraxel Dual 1550/1927 system (Solta Medical), operates at 2 wavelengths. The original wavelength (1550 nm) delivers heat deep into the reticular dermis; the 1927-nm setting, which is a superficial wavelength, penetrates 150 µm and works well for epidermal processes. A 10,000-nm wavelength has a high affinity for water and a high water absorption coefficient. As a result, the wavelength is absorbed by the water in the epidermis and does not penetrate into the dermis. The 1550-nm and 1927-nm wavelengths share a lower water absorption coefficient so that the water in the epidermis does not absorb all the energy and the wavelength can penetrate into the dermis. These wavelengths may be used in combination to focus on both epidermal and dermal conditions. Nonablative fractional resurfacing is popular with patients because of the convenience of not interrupting their daily activities. This procedure also is preferable for resurfacing in the treatment of acne scars. The repeated stimulation of the fibroblasts and wound healing causes continual improvement in the appearance and texture of skin with acne scars.[23,24]

Fractional photothermolysis is a safe way to resurface the skin, but it has limitations. For instance, it does not remove tissue, tighten the skin, or offer the same degree of improvement of deep rhytides as traditional CO_2 resurfacing. Because of a desire to combine the best of both worlds, fractional CO_2, which also is known as ablative fractional resurfacing (AFR), was developed. Ablative fractional resurfacing uses the technology of fractional photothermolysis but uses a 10,600-nm wavelength rather than 1550 nm. Instead of creating zones of coagulated tissue, this device creates microlesions or zones of ablated tissue surrounded by untreated tissue. The laser penetrates up to 1.6 mm into the tissue; thus the skin is not intact after treatment. However, the adjacent untreated keratinocytes repair the ablated epidermis in 48 hours. The spot size is less than 500 µm, which is optimal for quick epidermal healing due to the minimal distance that the keratinocytes must migrate.[24] Instead of the clinical downtime of 2 weeks associated with traditional CO_2 resurfacing, patients have 2 days of clinical downtime when treated with AFR. Clinical downtime refers to time that wound care is required, such as the application of petroleum jelly, vinegar, or water soaks. Once the skin is reepithelialized, the patient has 5 days of social downtime, meaning erythema and edema are present and are to such a degree that the patient stays indoors for the rest of the week. The reduced clinical downtime minimizes risk. This device also has a 2-mm ablative handpiece that can be used for destruction of epithelial growths and reshaping rhinophymatous noses.

Ablative and nonablative fractional technologies can be combined to meet patient needs. For example, eyelids and perioral rhytides can be treated with AFR and the remaining areas of the face treated with NFR. This method decreases downtime and risk but can enhance results. Depth and percentage of surface coverage also are controlled by the physician. Ablative fractional technology has advantages over nonablative resurfacing for deep wrinkles and laxity for patients who have time to recover. This device is preferable for the treatment of surgical, atrophic, and hypertrophic scars. With both methods of resurfacing, results continue to improve for 3 to 6 months due to collagen remodeling.[23,24]

CONCLUSION

Patients want to look as good as they feel. Rejuvenation of the aging face can be achieved with a variety of noninvasive treatments or a combination of treatments that have minimal downtime and risk. It is important to take into account the degree of volume loss, wrinkles, and photodamage when determining how to approach a patient and help him/her achieve a refreshed appearance.

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