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Minimally Invasive Procedural Treatments for Skin Laxity: A Review of the Literature

Jay Chittoor DO

Nazanin Saedi MD

Introduction

Skin tightening is an ever-growing component in the maintenance of a youthful appearance. In just the past 2 years, there has been over a 100% increase in the number of skin tightening procedures performed, in particular with the use of non-invasive technologies.[1] Most clinical practices use energy-based devices such as lasers, radiofrequency, or ultrasound, which employ heat in some form to denature and shorten collagen fibers for the remodeling effect.[2,3,4] Microcoring is the latest breakthrough, which stimulates neocollagenesis by removing microscopic full thickness cores of skin without the use of thermal energy.[5] Compared to the previous gold standard of rhytidectomy, these non-invasive approaches offer a reduced recovery time, decreased risk of scarring, and a significant improvement in mild to moderate wrinkles. This article aims to review and provide updates on current and new skin tightening devices.

Definition of Skin Laxity

The manifestations of skin laxity include fine and deep wrinkles, sagging, and the presence of cellulite.[6,7]These features are influenced by intrinsic factors such as age, stress, and genetics as well as extrinsic factors such as UV exposure and smoking. On a cellular level, there is increased inflammation and apoptosis of keratinocytes. Matrix metalloproteinases are upregulated resulting in the breakdown of type I and type III collagen.[8] On the other hand, elastin fibers increase within the papillary dermis in a process called elastosis; however, their haphazard arrangement annuls their ability to preserve skin tension.

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[1]Aesthetic Plastic Surgery National Databank Statistics 2020-2021, The Aesthetic Society

[2]Anderson RR, Parrish JA. Selective photothermolysis: precise microsurgery by selective absorption of pulsed radiation. Science. 1983;220(4596):524-527

[3]Delgado AR, Chapas A. Introduction and overview of radiofrequency treatments in aesthetic dermatology. J Cosmet Dermatol. 2022;21(Suppl. 1):S1–S10.

[4]MacGregor JL, Tanzi EL. Microfocused ultrasound for skin tightening. Semin Cutan Med Surg. 2013;32(1):18-25

[5]Pozner JN, Kilmer SL, Geronemus RG, Jack M, Burns JA, Kaminer MS. Cytrellis: A Novel Microcoring Technology for Scarless Skin Removal: Summary of Three Prospective Clinical Trials. Plast Reconstr Surg Glob Open. 2021 Oct 29;9(10):e3905.

[6]Tobin DJ. Introduction to skin aging. J Tissue Viability. 2017;26(1):37-46

[7]Khan MH, Victor F, Rao B, Sadick NS. Treatment of cellulite: Part I. Pathophysiology. J Am Acad Dermatol. 2010;62(3):361-372

[8]Shin JW, Kwon SH, Choi JY, Na JI, Huh CH, Choi HR, Park KC. Molecular Mechanisms of Dermal Aging and Antiaging Approaches. Int J Mol Sci. 2019 Apr 29;20(9):2126

Lasers

Lasers have become an indispensable tool for skin tightening since the conceptual development of selective photothermolysis in the early 1980s.[2] This principle explains that certain chromophores in the skin such as hemoglobin, melanin, or water can be targeted to absorb wavelengths of light more strongly compared to surrounding tissue. The energy is delivered in a pulsed fashion and the result is a precise and controlled amount of thermal damage. At approximately 65°C, collagen fibers denature with the rupturing of intramolecular hydrogen bonds; however, the intermolecular hydrogen bonds remain stable.[9] As the target tissue cools, these collagen fibers then shorten, tightening the skin. Additionally, the energy delivered results in the activation of heat shock proteins, which increase expression of cytokines like TGF-beta that add to the fibrogenic process.[10] Longer wavelengths penetrate more deeply and the combination with higher energy can enhance the overall reduction of wrinkles.

Fully Ablative Lasers

The main types of lasers involved are classified into ablative and nonablative modalities. Ablative lasers are designed with a CO_2 gas source or an erbium doped yttrium-aluminum-garnet crystal (Er:YAG), and both target the water chromophore. Compared to Er:Yag, the CO_2 laser is capable of delivering more energy and to deeper depths in the skin.[11,12] These lasers treat wrinkles through complete removal of the epidermis and upper dermis. While patients benefited from the ensuing collagen remodeling, the procedures were often associated with potential side effects of scarring, herpes simplex viral flares, dyspigmentation, and erythema lasting for months.[13]

Ablative Fractional Lasers

Fractional devices addressed these concerns by focusing laser beams into miniature channels or microthermal zones (MTZs) with intervening normal skin.[14] With the introduction of spared areas in the treatment site, re-epithelization occurs rapidly within a

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[9]Arnoczky SP, Aksan A. Thermal modification of connective tissues: basic science considerations and clinical implications. J Am Acad Orthop Surg. 2000;8:305-313.

[10]Capon A, Mordon S. Can thermal lasers promote skin wound healing? Am J Clin Dermatol. 2003;4(1):1-12

[11]Alster TS, Lupton JR. Erbium:YAG cutaneous laser resurfacing. Dermatol Clin. 2001 Jul;19(3):453-66

[12]Alster, Tina S., and Sanjay Garg. "Treatment of facial rhytides with a high-energy pulsed carbon dioxide laser." Plastic and reconstructive surgery 98.5 (1996): 791-794

[13]Nanni CA, Alster TS. Complications of carbon dioxide laser resurfacing. An evaluation of 500 patients. Dermatol Surg1998;24:315–320

[14]Manstein D, Herron GS, Sink RK, Tanner H, Anderson RR. Fractional photothermolysis: a new concept for cutaneous remodeling using microscopic patterns of thermal injury. Lasers Surg Med. 2004;34(5):426-38

day and thus the downtime is dramatically reduced after the procedure. This technology was first applied for tissue tightening in 2009 with the use of the fractional CO_2 device.[15] With 1-2 treatments on the face, the aesthetic results were comparable to multiple passes of traditional ablative CO_2 but with shorter healing time. Another study displayed effective reduction in lower eyelid skin laxity by 65.3% as reported by patients, after 2-3 sessions of fractional CO_2.[16] For a more objective assessment, Naouri et. Al[17] demonstrated a 5.9% increase in skin elasticity after a single session of fractional CO_2 on the face using a skin elastic meter.

Nonablative Fractional Lasers

Non-ablative fractional devices have also had clinical benefit in skin tightening. Examples of these lasers include Fraxel® and Palomar StarLux ®.[18] With non-ablative fractional resurfacing, MTZs are generated without damaging epidermis via controlled heating. There is a reduced risk of dyspigmentation post-procedurally, which is beneficial in treating darker skin phototypes. The focal dermal coagulated tissue is dubbed microepidermal necrotic debris (MENDs).[19,20] These MENDs are extruded through the skin about 7 days after treatment, which trigger basal layer regeneration, aiding in the cosmetic resurfacing effect. The energy applied also activates heat shock proteins, which result in collagen thickening, similarly to ablative lasers. However, these lasers do not generate the same degree or depth of energy delivery compared to their ablative counterparts. As a result, multiple passes along with multiple treatments are needed to achieve a mild to moderate improvement in skin laxity.

There are a few studies exploring the use of non-ablative lasers in acne scar resurfacing. A randomized control trial involving 87 patients who were treated with one session with Erbium-glass 1540nm laser produced visible reduction in all severity of boxcar and icepick acne scars[21].

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[15]Rahman Z, MacFalls H, Jiang K, Chan KF, Kelly K, Tournas J, Stumpp OF, Bedi V, Zachary C. Fractional deep dermal ablation induces tissue tightening. Lasers Surg Med. 2009 Feb;41(2):78-86

[16]Tierney EP, Hanke CW, Watkins L. Treatment of lower eyelid rhytids and laxity with ablative fractionated carbon-dioxide laser resurfacing: case series and review of the literature. J Am Acad Dermatol 2011;64:730–40.

[17]Naouri M, Atlan M, Perrodeau E, et al. Skin tightening induced by fractional CO2 laser treatment: quantified assessment of variations in mechanical properties of the skin. J Cosmet Dermatol 2012;11: 201–6.

[18]Preissig J, Hamilton K, Markus R. Current Laser Resurfacing Technologies: A Review that Delves Beneath the Surface. Semin Plast Surg. 2012 Aug;26(3):109-16

[19]Laubach H, Tannous Z, Anderson R, Manstein D. Skin responses to fractional photothermolysis. Lasers Surg Med 2006;38:142-9..

[20]Kauvar AN. Fractional nonablative laser resurfacing: is there a skin tightening effect?. Dermatol Surg. 2014;40 Suppl 12:S157-S163.

[21]Bencini PL, Tourlaki A, Galimberti M, et al. Nonablative fractional photothermolysis for acne scars: clinical and in vivo microscopic documentation of treatment efficacy. Dermatol Ther. 2012;25(5):463-467.

This was noted by confocal microscopy and blinded, independent physician assessments. Burns have also benefited from non-ablative lasers. Three sessions of Erbium-glass 1540nm, 4 weeks apart produced moderate to significant improvement in erythema, dyspigmentation and texture according to patient scores and clinical photos.[22] Patients have also experienced improvement with eyelid laxity. After 3-7 sessions of the 1550nm NAFR laser, demonstrated eyelid contraction occur, but just over 55% of patients reported increased widening of the eye apertures.[23]

Risks: Fractionated Lasers

Fractionated lasers all have the potential side effects similar to their fully ablative counterparts to include prolonged erythema, dyspigmentation, and scarring albeit with less severity. Typical procedural erythema should last no more than 1 month for ablative lasers and 4 days for non-ablative lasers.[24] Topical steroids, ascorbic acid, and LED photomodulation with 590nm wavelength can be used for treatment. Both hyperpigmentation and hypopigmentation can be minimized with sun protection 2 weeks before and after laser procedures. Topical hydroquinone or superficial chemical peels can hasten the return of natural complexion in hyperpigmented lesions; however, hypopigmentation which often occurs several weeks later is more difficult to treat. Re-pigmentation can occur through the use of retinoids, calcineurin inhibitors, and prostaglandin analogs.[24,25] Scarring can result from a multitude of reasons such as high treatment density or poor patient selection for those with a history keloids. Corticosteroid injections, silicone gel, and judicious repeat use of a fractionated ablative laser can assist with this complication.

Radiofrequency

Radiofrequency (RF) technology has been used for over a century in medicine, initially for hemostasis during surgeries.[26]

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[22]Haedersdal M, Moreau KE, Beyer DM, Nymann P, Alsbjørn B. Fractional nonablative 1540 nm laser resurfacing for thermal burn scars: a randomized controlled trial. Lasers Surg Med. 2009 Mar;41(3):189-95

[23]Sukal SA, Chapas AM, Bernstein LJ, Hale EK, Kim KH, Geronemus RG. Eyelid tightening and improved eyelid aperture through nonablative fractional resurfacing. Dermatol Surg. 2008;34(11):1454-1458.

[24]Metelitsa AI, Alster TS. Fractionated laser skin resurfacing treatment complications: a review. Dermatol Surg. 2010;36(3):299-306.

[25]Massaki AB, Fabi SG, Fitzpatrick R. Repigmentation of hypopigmented scars using an erbium-doped 1,550-nm fractionated laser and topical bimatoprost. Dermatol Surg. 2012;38(7 Pt 1):995-1001.

[26]Fisher GH, Jacobson LG, Bernstein LJ, Kim KH, Geronemus RG. Nonablative radiofrequency treatment of facial laxity. Dermatol Surg. 2005;31(9 Pt 2):1237-1241

However, over the past 2 decades, new devices were adapted to treat skin laxity. RF employs an alternating electrical current to generate an electric field between two electrodes on the surface of the skin.[27-28] Charged molecules vibrate and generate heat while moving through the tissue. The inherent tissue resistance and time by which these molecules traverse determines the magnitude of electrical current converted to thermal energy. This heating process results in collagen protein denaturation and tissue retraction as the thermal effect resolves. Furthermore, just like in lasers, heat shock proteins within fibroblasts are activated and stimulate production of new collagen.

Mechanism of Action and Device Characteristics

RF devices are characterized by the electrodes used-monopolar, bipolar, and multipolar.[29] Each have their own specific advantages. Monopolar electrodes deliver a direct electrical current that can penetrate deeply into skin over 20mm, which make them excellent choices for deeper rhytids.[30] However, there is a higher chance of epidermal heating and thus significant cooling is required during the procedure. Bipolar and multipolar configurations emit current between electrodes at a fixed distance. Treatment depth is more superficial, but these devices cover greater skin surface area and provide more control over the energy delivered.

Other important parameters that affect the depth of penetration are frequency, skin topography, and tissue conductivity.[28] Frequency is inversely proportional to depth of thermal energy delivered. Low frequencies are ideal for treatment beyond the reticular dermis and would provide bulk heating. Skin topography can be analyzed via tools such as confocal laser scanning microscopy or interferometry to create a 3D visualization of skin texture, represented by the organization of furrows and ridges of the epidermis.[31] The distance between these furrows and ridges increases during the aging process and thus alter penetration depth during RF treatment. Higher tissue conductivity between the epidermis, dermis, and fat is another key component to increase treatment depth.[3] Pre-warming tissue is one way to improve conductivity, and this can result in lower voltage settings on RF devices, allowing less pain during the procedure.

There are several methods to deliver radiofrequency to include stamping, continuous movement, fractionated, hands free, and subdermal activation. In particular, fractionated

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[27]Dayan E, Burns AJ, Rohrich RJ, Theodorou S. The Use of Radiofrequency in Aesthetic Surgery. Plast Reconstr Surg Glob Open. 2020 Aug 17;8(8):e2861

[28]Duncan DI, Kreindel M. Basic radiofrequency: physics and safety and application to aesthetic medicine. In: Lapidoth M, Halachmi S, eds. Radiofrequency in Cosmetic Dermatology. S. KARGER AG;2014:1-22; 86-91

[29]Delgado AR, Chapas A. Introduction and overview of radiofrequency treatments in aesthetic dermatology. J Cosmet Dermatol. 2022 Oct;21 Suppl 1:S1-S10.

[30]Alexiades-Armenakas M, Dover JS, Arndt KA. Unipolar versus bipolar radiofrequency treatment of rhytides and laxity using a mobile painless delivery method. Lasers Surg Med. 2008 Sep;40(7):446-53

[31]Diosa JG, Moreno R, Chica EL, Villarraga JA, Tepole AB. Changes in the three-dimensional microscale topography of human skin with aging impact its mechanical and tribological behavior. PLoS One. 2021 Jul 9;16(7):e0241533

techniques have been popular in conjunction with microneedling, as the mechanical trauma from microneedling also promotes collagen remodeling.[3] These types of radiofrequency devices may incorporate non-insulated needles to deliver energy uniformly across the length of the needle or utilize insulated needles to focus the energy at the tip, resulting in less epidermal heating. In addition to the enhanced skin tightening effects, microneedling has been deemed safe in all skin types, indicated by decreased risk of burns and dyspigmentation.

Uses and Side Effects

Given patients' degree of skin aging as well as RF device characteristics, the number and spacing of each RF session may vary. One study in a Korean population used monopolar RF with 3 sessions every 2 weeks for periorbital wrinkles, resulting in an average of 20% improvement in appearance as reported by the patients.[32] Non-insulated RF microneedling was performed on a set of 98 Chinese patients to enhance neck firmness; however, patients reported beneficial results anywhere from 1-3 sessions, each spaced a month apart.[33] For abdominal laxity, multipolar RF achieved significant skin tightening in about 6 sessions, each about 1-3 weeks apart[34]

Minor expected side effects from RF include temporary pain, erythema, and swelling at the treatment site usually resolving within 48 hours. More serious complications result from tissue overheating, resulting in blistering, full thickness burns, and eschar formation.[28] An important contraindication to RF is the presence of a pacemaker or other implantable cardioverter-defibrillator, and thus it is critical to screen these patients beforehand.

Ultrasound

Ultrasound was first introduced for skin tightening in 2009 when the Food and Drug Administration approved its use for eyebrow lifts.[35] Over the past 14 years, this technology has been expanded to treat other parts of the face, arms, legs, and décolleté area.[36] The mechanism involves using high intensity frequency ultrasound waves (HIFU) to create friction through molecular vibration, and thus selectively heat and induce coagulation necrosis of target tissue.[37] HIFU was previously used for ablation of solid organ tumors

[32]Roh NK, Yoon YM, Lee YW, Choe YB, Ahn KJ. Treatment of periorbital wrinkles using multipolar fractional radiofrequency in Korean patients. Lasers Med Sci. 2017;32(1):61-66.

[33]Xiao B, Jiang Y, Wang B, et al. A retrospective study of neck rejuvenation using a noninsulated microneedle radiofrequency in Chinese subjects. Lasers Med Sci. 2021;36(6):1261-1266

[34]Royo de la Torre J, Moreno-Moraga J, Muñoz E, Cornejo Navarro P. Multisource, Phase-controlled Radiofrequency for Treatment of Skin Laxity: Correlation Between Clinical and In-vivo Confocal Microscopy Results and Real-Time Thermal Changes. J Clin Aesthet Dermatol. 2011 Jan;4(1):28-35.

[35]Contini M, Hollander MHJ, Vissink A, Schepers RH, Jansma J, Schortinghuis J. A Systematic Review of the Efficacy of Microfocused Ultrasound for Facial Skin Tightening. Int J Environ Res Public Health. 2023;20(2):1522. Published 2023 Jan 13.

[36]Alam M, White LE, Martin N, et al. Ultrasound tightening of facial and neck skin: A rater-blinded prospective cohort study. J Am Acad Dermatol. 2010;62:262-269

[37]Zhou YF. High intensity focused ultrasound in clinical tumor ablation. World J Clin Oncol. 2011 Jan 10;2(1):8-27.

since the 1990s; however the difficulty in fine tuning the dose and placement depth of energy resulted in the development of a specialized version of HIFU known as microfocused ultrasound (MFU).[38]

Microfocused Ultrasound

Microfocused techniques create multiple thermal injury zones (TIZ) about $1mm^3$ in size at a predetermined depth within the superficial muscular aponeurotic system (SMAS) or deep dermal layers. Unlike standard HIFU, MFU delivers short, low energy pulses, to achieve target temperatures of about 60-70 degrees C, subsequently denaturing and remodeling the collagen.[39] Transducers can be switched to modify the energy and frequency parameters. When performing the procedure on the face, the target areas such as the cheeks or brows, are outlined with a skin marker and subdivided into compartments. These compartments have a set number of designated treatment lines when applying the ultrasound probe to determine the optimal energy delivery. Furthermore, the number and direction of these lines (linear horizontal, criss-cross, vertical) can also enhance the aesthetic outcomes.[40]

In a review of MFU treatments for the brow, submentum, and marionette lines, patients reported mild to moderate improvement after just one treatment assessed by the Investigator Global Aesthetic Improvement Scales (IGAIS) as well as the Subject Global Aesthetic Improvement Scales (SGAIS).[35] Suh et al[41] displayed histopathological results before and 2 months after treatment of the face in 22 Korean patients. Post procedural tightening was observed with the increase in dermal collagen as well as the straightening of elastic fibers. The application of MFU beyond the face was first performed by Alster and Tanzi.[42] In a split study on arms and legs of 18 women, double plane treatment in a single session with the 4-MHz 4.5-mm-depth and 7-MHz 3-mm-depth transducer was proven to be more effective compared to single-plane treatment with the 4-MHz 4.5-mm-depth transducer alone after 6 months, using global assessment scores.

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[38]Park JY, Lin F, Suwanchinda A, et al. Customized Treatment Using Microfocused Ultrasound with Visualization for Optimized Patient Outcomes: A Review of Skin-tightening Energy Technologies and a Pan-Asian Adaptation of the Expert Panel's Gold Standard Consensus. J Clin Aesthet Dermatol. 2021;14(5):E70-E79

[39]MacGregor JL, Tanzi EL. Microfocused ultrasound for skin tightening. Semin Cutan Med Surg. 2013;32(1):18-25

[40]Sasaki GH, Tevez A. Clinical efficacy and safety of focused-image ultrasonography: a 2-year experience. Aesthet Surg J. 2012 Jul;32(5):601-12.

[41]Suh DH, Shin MK, Lee SJ, Rho JH, Lee MH, Kim NI, Song KY. Intense focused ultrasound tightening in Asian skin: clinical and pathologic results. Dermatol Surg. 2011 Nov;37(11):1595-602.

[42]Alster TS, Tanzi EL. Noninvasive lifting of arm, thigh, and knee skin with transcutaneous intense focused ultrasound. Dermatol Surg. 2012; 38:754-759

The main side effects of ultrasound include local erythema and edema at the treatment site, which resolve within 48 hours.[43] Patients may also experience urticaria that can last from 2 days up to 2 months; in rare cases there has been some atrophic scarring. Blistering, erosions, or ulcerations may result if the transducer is not properly coupled with the skin surface or if there is excess gel on the treatment field, which will affect the penetration depth of ultrasound waves. Lastly, motor nerve paresis may occur particularly to the marginal mandibular branch of the facial nerve due to its superficial course near the mandible. This is thought to be a result of procedural inflammation and is expected to resolve in 2-6 weeks.[44]

Synchronous Ultrasound Parallel Beam Technology

Most recently in the past 2 years, there has been a significant advancement in ultrasound technology with the use of the Synchronous Ultrasound Parallel Beam (SUPERB™) device created by Sofwave Medical Ltd.[45] This device incorporates seven non-focused parallel beams with both high energy and frequency, providing higher treatment coverage per pulse compared to its predecessors. Ultrasound depth can extend on average to 1.5mm and a built-in contact cooling system prevents epidermal damage. In a study with 58 participants, almost 88% reported improvement in lower face and neck laxity after one treatment. This was calculated by independent physician assessments of pre and post procedural photos. Another study with 32 participants also reported eyebrow lifting as indicated by increases in average and maximal eyebrow heights.[46] Additionally, SUPERB™ ultrasound technology has been FDA approved for the treatment of cellulite as well as facial acne scars. [47,48] Unlike other ultrasound modalities, there has been no significant adverse events reported thus far. [45,46]

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[43]Friedmann DP, Bourgeois GP, Chan HHL, Zedlitz AC, Butterwick KJ. Complications from microfocused transcutaneous ultrasound: Case series and review of the literature. Lasers Surg Med. 2018;50(1):13-19.

[44]Missel L. Prevention of potential adverse events associated with use of Ulthera device. Tech Bull, 2011.

[45] Wang JV, Ferzli G, Jeon H, Geronemus RG, Kauvar A. Efficacy and Safety of High-Intensity, High-Frequency, Parallel Ultrasound Beams for Fine Lines and Wrinkles. Dermatol Surg. 2021;47(12):1585-1589

[46]Wang JV, Bajaj S, Kauvar A, Geronemus RG. Eyebrow Lifting From High-Intensity, High-Frequency, Parallel Ultrasound Beams. Dermatol Surg. 2023;49(7):718-720

[47]Sofwave Ltd. Sofwave Medical Announces FDA Clearance of SUPERB™ Technology For Cellulite. https://sofwave.com/news/sofwave-medical-announces-fda-clearance-of-superb-technology-for-cellulite"https://sofwave.com/news/sofwave-medical-announces-fda-clearance-of-superb-technology-for-cellulite. Published 2022 Dec 19

[48]Sofwave Ltd. Sofwave Medical Announces FDA Clearance of SUPERB™ Technology For Treatment of Acne Scars. https://sofwave.com/news/fda-clearance-for-treatment-of-acne-scars. Published 2023 Aug 30"https://sofwave.com/news/fda-clearance-for-treatment-of-acne-scars. Published 2023 Aug 30

Thermo-mechanical Fractional Injury

Another energy-based treatment that has developed over the past decade for the treatment of wrinkles as well as overall facial rejuvenation, is the Tixel® device.[49] It operates through the concept of thermo-mechanical fractional injury(TMFI). Thermal energy is transmitted through the handpiece tip, which consists of an array of miniature titanium pyramids. As the device is activated, these pyramids rapidly protrude directly into the skin and form a crater, resulting in evaporation and desiccation of target tissue. There is no penetrative damage from the pyramids; instead, the treatment results in a non-ablative heat injury. Higher energies can be delivered by increasing the pulse duration and the protrusion length from the handpiece.

Elman et al first explored the use of Tixel® for facial skin laxity in 2016 with 8 patients, ranging from Fitzpatrick skin type II-IV.[49] They noted a 75% reduction in the Fitzpatrick Wrinkle Classification System (FWCS) after 3 sessions spaced about a month apart. More recent studies with TMFI have shown benefit in the treatment of periorbital rhytids. In one randomized prospective study, 3-5 monthly sessions of TMFI displayed comparable results to non-ablative fractional lasers with the same frequency (laser settings were based on manufacturer recommendation for periorbital rhytids).[50] Wang et. al further validated the safety and efficacy of TMFI, and illustrated a sustained reduction in rhytids 3 months out after 4 treatments.[51]

There have been no serious adverse events with TMF, and minor erythema and swelling lasts about 24-48 hours post-procedurally.[49-51] Furthermore, patients do not require any form of anesthesia as opposed to some other energy-based devices. In comparison to lasers, there is no need for eye protection for either patient or providers.

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[49]Elman M, Fournier N, Barnéon G, Bernstein EF, Lask G. Fractional treatment of aging skin with Tixel, a clinical and histological evaluation. J Cosmet Laser Ther. 2016;18(1):31-37

[50]Daniely D, Judodihardjo H, Rajpar SF, Mehrabi JN, Artzi O. Thermo-Mechanical Fractional Injury Therapy for Facial Skin Rejuvenation in Skin Types II to V: A Retrospective Double-Center Chart Review. Lasers Surg Med. 2021;53(9):1152-1157

[51]Wang JV, Bajaj S, Orbuch D, et al. Safety and Efficacy of a Thermomechanical Fractional Injury Device for Periorbital Rhytides. Dermatol Surg. 2023;49(4):374-377

Microcoring

Dermal micro-coring (DMC) is a novel, non-invasive, non-energy-based technology, currently being used to treat moderate to severe rhytids.[52,53] In this procedure, hypodermic needles are inserted through the skin to a depth of about 400 microns, and a full thickness core of tissue is removed. These needles are applied in a predefined grid pattern of $1x1cm^2$ and advanced across the treatment area sequentially. A vacuum system on the DMC device ensures appropriate contact and prevents accumulation of tissue within the needles. A minimum of 6000 and maximum of 24,000 cores can be extracted in each session. Remarkably, the designed depth and spacing between the needles result in no scar formation when these cores are removed. Furthermore, these micro wounds often close immediately after patients leave the office.

The mid to lower face has been the primary treatment site for DMC thus far. In particular, DMC has shown improvement in perioral rhytids and marionette lines, which has been difficult to achieve with other non-invasive modalities or face lift surgery. The overall improvement was characterized by a reduction 1.3 on the Lemperle Wrinkle Severity Scale (LWSS) as well as an increase of 1.5 in GAIS compared to baseline after 90 days.[52]

The main side effects of DMC are similar to microneedling procedures with local erythema, edema, ecchymosis and pruritus[52]. Unlike other heat based devices, there has currently been no long term risk of dyspigmentation, infection, and deep scarring. Further research should explore extra facial sites for skin tightening and optimize treatment parameters such as frequency or number of passes.

Conclusion

The landscape of skin tightening has transformed over the past two decades with continual advancements in non-invasive technology. Although it is still not a replacement for surgery, many advances have been made. From energy based treatments to new micro-coring approaches, patients have more options than ever to improve their aesthetic results. More studies should be pursued to compare these modalities and investigate if combination therapies could produce synergetic results.

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[52]Pozner JN, Kilmer SL, Geronemus RG, Jack M, Burns JA, Kaminer MS. Cytrellis: A Novel Microcoring Technology for Scarless Skin Removal: Summary of Three Prospective Clinical Trials. Plast Reconstr Surg Glob Open. 2021 Oct 29;9(10):e3905

[53]Gfrerer L, Kilmer SL, Waibel JS, Geronemus RG, Biesman BS. Dermal Micro-coring for the Treatment of Moderate to Severe Facial Wrinkles. Plast Reconstr Surg Glob Open. 2022;10(10):e4547. Published 2022 Oct 17.