Scars (acne scars) Enhancement (Treatment)

A: Acne Scars

Introduction

It has been written that "there is no single disease which causes more psychic trauma, more maladjustment between parent and children, more general insecurity and feelings of inferiority and greater sums of psychic suffering than does acne vulgaris." Acne scars lead to emotional debilitation, embarrassment, poor self-esteem, social isolation, preoccupation, low confidence, altered social interactions, body image alterations, identity difficulties, anger, frustration, confusion, unemployment, lowered academic performance, exacerbation of psychiatric disease, anxiety, or depression.

Treatment of the true scars resulting from acne must reflect several considerations by the physician. Cost of treatment, severity of lesions, physician goals, patient expectations, side-effect profiles, psychological or emotional effect to the patient, and prevention measures should all play a role. The ultimate goal of any intervention is for improvement, not for a total cure or perfection. The therapies / techniques used for the treatment of acne scars are to be individualized, taking into consideration many factors like age, gender, Fitzpatrick skin phototype, site of scars, clinical type of acne scars, grading of scars, socioeconomical constraints, psychological and physical health of the patient, etc. Various treatment modalities available for acne scars are topical therapies, chemical peelings, microneedling or microdermabrasion, subcision, autologous / nonautologous dermal fillers, fractionated / nonfractionated lasers, ablative / nonablative lasers, pigment or vascular-specific lasers, pigment transfer techniques, and minor surgical procedures. Many a times, combination of these modalities is required to obtain satisfactory results in an individual patient.

What are The Types of Acne Scars?

The two causes of acne scar formation can be broadly categorized as either a result of increased tissue formation or, the more common cause, loss or damage of tissue.

1. Excess Tissue formation (Hypertrophic and Keloidal Scars)

Two examples of excess tissue presence are **hypertrophic scars and keloids.** Hypertrophic scars are confined within the margins of the original injury. These scars are most prevalent within the first couple of months post injury, and then, in contrast to keloids, tend to normally mature with occasional spontaneous regression. However, some do also worsen. These scars are most often less bothersome and treatment may or may not be needed based on severity. Keloids are a human-specific phenomenon that is characterized by disproportionate creation and deposition of collagen with an excess outside of the original injury margins. They are commonly found on the chest, back, shoulders, and ears. These lesions are very persistent and are familial and genetic influences. Clinically, there may be pain, itching, burning, or limited range of motion.

2. Loss of Tissue (Icepick, Boxcar and Rolling Scars)

The other cause of scars, loss or damage of tissue, is demonstrated by the 3 primary acne scars as: icepick, rolling, and boxcar.

Ice Pick Scars

The icepick scars are usually smaller in diameter (less than 2 mm) and deep with tracts to the dermis or subcutaneous tissue. Although the orifice is smaller and steep-sided, there may be a wide base that could evolve into a depressed, boxcar scar. Commonly these are seen on the cheeks. Their depth is below that reached with conventional skin resurfacing options. Treatment is frequently done by punch excision with closure by small suture along relaxed skin tension lines. Non-absorbable suture is preferred because of the predisposition of the skin to scar and the inflammatory response seen with absorbable.

Rolling scars

Soft rolling scars can be circular or linear, are often greater than 4 mm in diameter, and have gently sloped edges that merge with normal-appearing skin. Rolling scars occur from dermal tethering of otherwise relatively normal-appearing skin and are usually wider than 4 to 5 mm. Abnormal fibrous anchoring of the dermis to the subcutis leads to superficial shadowing and a rolling or undulating appearance to the overlying skin. Although they tend to be shallow, the subdermal tether precludes treatment from the surface above. So treatment is commonly by subcision. An additional, sometimes categorized class, atrophic scars, exhibit a slightly wrinkled texture and may be somewhat pigmented because of the underlying vasculature. Treatment is most often with abrasion, excision, or augmentation.

Boxcar scars

Boxcar scars are round to oval depressions with sharply demarcated vertical edges, similar to varicella scars. They are clinically wider at the surface than icepick scars and do not taper to a point at the base. They may be shallow (0.1-0.5 mm) or deep (≥ 0.5 mm) and are most often 1.5 to 4.0 mm in diameter. Shallow boxcar scars are within the dermal reach of skin resurfacing treatments (such as laser skin resurfacing), but deeper boxcar scars are resistant to improvement in the absence of full-thickness treatment of the scar most often done by punch excision, elevation, or other modality.

Erythematous Scars

The resolving acne site's initial presentation may be pink or red but usually improves. For erythematous scarring or marking, home care, skin products and/or vascular laser, is all that is required. It is probably better to consider vascular lasers in a patient in whom the predominant scar type is erythematous, although it is worthwhile knowing that it may have a positive effect on other atrophic and hypertrophic scar types if they are also present. Non ablative fractional lasers especially (1,550nm) are useful for erythematous scars.

Hyperpigmented scarring

Postinflammatory hyperpigmentation is a very commonly seen variant. It is a black or brown residual discoloration in the location of previous acne or other inflammatory reaction. These lesions are more common in those with darker skin or those who tan. Fading may occur but quite frequently takes a prolonged time period, sometimes up to a year**.** Chemical peels, lasers, or bleaching agents are usually the first-line therapies. Pigment-specific lasers (q-switched Nd:YAG 1064nm) and possibly intense pulsed light, and the 1,927-nm thulium fractionated laser, are the most likely to succeed with pigmented scars.

Hypopigmented Macular Scarring

Hypopigmentation is a loss of pigment in the area of the lesion. It can range from lightening to total whitening of the skin. Often these areas do not regain the level of previous pigmentation and only late if so. Multiple treatments can be considered for all of these pigmentary lesions after the acne is adequately addressed. Current treatment modalities include medical treatment (immunomudlators, retinoids) skin grafting, scar excision or revision, cosmetic camouflage, cosmetic tattooing, dermabrasion, chemical peels and various forms of photo- and laser therapy. The one agreed-on facet is that the most effective treatment for both the true scars and pigmentary changes is to prevent and control the acne lesions themselves to limit inflammation and other sequelae.

Topical immunomodulatory drugs such as calcineurin inhibitors (tacrolimus and pimecrolimus) have been used successfully in the treatment of vitiligo not only because of their anti-inflammatory characteristics affecting activation of T cells, but also because a direct interaction between calcineurin inhibitors and keratinocytes creates a favorable milieu for melanocytic growth and migration.

Although **topical retinoids** have been mostly used in the treatment of pigmentary disorders such as melasma, actinic lentigines, and postinflammatory hyperpigmentation, tretinoin has demonstrated bifunctional effects on pigmentation of melanocytes; it may stimulate melanogenesis by inducing melanocyte differentiation and may at the same time inhibit melanogenesis by removing mature melanocytes through apoptosis.

There have been scattered reports of repigmentation after **manual dermabrasion** and **needle dermabrasion** (using a tattoo gun without pigment). Some pigment transfer procedures have been attempted. A number of techniques used to treat vitiligo may also be useful in treating certain types of superficial hypopigmented scarring. **Minigrafting** holds some promise, although there appears to be less spread of pigment from the grafts into surrounding skin in patients with scarring than in those with vitiligo.

If the appearance of hypopigmented scarring is contrasted with surrounding area of hyperpigmentation, treatment should be direct to decrease contrast by treating hyperpigmentation with sunscreens, bleaching preparations, light skin peeling and non-ablative fractional laser1,550- nm laser. Another new midinfrared wavelength, thulium (1,927 nm) laser is effective for the treatment of postinflammatory hyperpigmentation and melasma that commonly highlight hypopigmented scarring.

Grading of Acne Scars

Grading postacne scarring has been looked at as an exercise in morphological assessment of individual scars. This is required so that one can plan treatment specifically for this scar. A rolling type scar may be filled or resurfaced, a punched out scar grafted, elevated, or excised, a deeply atrophic scar may need fat transfer, hypertrophic scars may need intralesional injections, and other scenarios require similarly specific treatment.

Grade 1 Mild Scarring (Macular Scarring)

This grade is all about the skin surface discoloration (erythematous, hyperpigmented, or hypopigmented) and is visible to an observer up close and from a distance. Also it is obvious at a distance without make-up. Many women will apply concealers and thick makeup to camouflage marks and render themselves liable to secondary comedonal changes of acne cosmetic. The facial reconstruction paradigm focuses on improvement in the skin's surface in this level of scarring. Color is important to patients, because we tend to judge the health and age of an individual based partly on the evenness of their skin color. Movement and volume concerns and surgical options have no bearing with this level of scarring

Grade 2 Mild Scarring (Mild Atrophic or Hypertrophic Scarring)

Grade 2 scarring is again mainly about the skin surface. It is mild, atrophic, or hypertrophic disease, which may not be obvious at a social distance (e.g., talking to someone conversationally in normal lighting) and is easily covered with make-up. This type of scarring is in most part loss of even skin glow due to altered collagen reflectance from the scarred dermis and shadows cast by the scars. This is particularly obvious to patients looking in the mirror at home or with lighting from above. Usually this is mild atrophic disease, but occasionally mild papular scarring will produce small protuberances especially on the nose or chin.

Treatment

The treatment of more-minor degrees of scarring has always presented a special challenge. It takes us closer to disobeying Hippocrates first rule of medical practice "first do no harm." The treatments should not be of high risk because the scars may not be as problematic to a patient as the results of overtreatment. Fortunately, we now have some options that are appropriate in their risk profile with the severity of the scars we are treating. We no longer are required to deeply peel, dermabrade, or fully ablate the skin with lasers for the more-minor forms of scars. In the past we have had to accept these procedures as the standard of care despite the incidence of adverse reactions associated with their use. Choice exists, and although on occasion harsher remedies may be required for these lesser grades of scars, most often, we can choose from the range of comparatively gentler forms of therapy.

In the facial reconstruction paradigm, skin surface improvement is required. This concentrates on procedures that will increase or reduce collagen and mild volume

changes such as those offered by superficial dermal fillers such as hyaluronic acid, fine-wire diathermy, intralesional corticosteroids, and fluorouracil. Skin needling or rolling is a good low-cost possibility for localized or general mild scarring. Microdermabrasion, chemical peel, non ablative skin resurfacing; and non ablative fractional skin resurfacing may also be used for generalized or localized scarring.

Chemical Peel

Chemical peels are another prospect for addressing the scarring left from acne lesions. These can be from superficial to deep effect and, unless the very deep peels are used, are generally considered for milder acne scarring and certainly not icepick or keloid scars. Light or superficial peels include alpha hydroxyl acid (glycolic, lactic, citric) or beta hydroxy acid (salicylic), Jessner's solution, modified Jessner's solution, resorcinol, and low-strength (concentration 10%) trichloroacetic acid. Usually multiple treatments are necessary for efficacy.

Microdermabrasion

It has been suggested that microdermabrasion is useful in the treatment of facial scarring. Microdermabrasion is a usually painless, superficial treatment with more texture benefit than permanent surface change. There are variable results seen and multiple sessions are frequently required. The most improvement is achieved with fine wrinkles and post-inflammatory hyperpigmentation, although superficial acne scars may benefit from deeper, more aggressive settings. It may owe its efficacy to changes in skin barrier function with its consequent transepidermal water loss. Improvement is likely to be mild, making it useful in this grade of scarring. However, multiple treatments are required

Manual needling, Skin Rolling or Derma Pen

It may be brought into play particularly when expensive machinery is not desirable or available. In its simplest form, a 30-G needle may be introduced into the skin to a controlled depth of 2 to 3 mm. For small areas of scarring, a small artery forceps is held 2 to 3 mm from the tip, and the skin is stabbed repeatedly. For larger areas, a tattoo gun without pigment or a needle-studded rolling pin may be used. Recently, the Dermapen handheld microneedling device is intended for scar therapy and treatment of burns, among other things. Constructed of multiple needles that vertically pierce the skin, the device stimulates collagenesis. Phase one begins with the release of growth factors and new epidermal growth, fibroblast chemo-taxis and proliferation, as well as matrix production. Tissue regeneration continues with the release of growth factors from fibroblasts, keratinocytes and monocytes. The dermal trauma heals with collagen remodelling, which is responsible for any improvement in atrophic scarring. This can also be readily added to other procedures such as dermal augmentation or fat transfer.

Nonablative Lasers

Nonablative therapies, include multiple wavelength lasers, pulsed light, and other forms of energy delivery. Because these modalities are less aggressive

as a whole, they are more useful for atrophic, rolling, or possibly hypertrophic scars rather than icepick, boxcar, or keloid scars. The morphology of the scar seems to be more predictive of results than the extent or amount. In addition, these therapies are more often used with darker skin types because ablative management tends to have a higher risk of pigmentary alterations. In general, there is selective thermal stimulation of dermal collagen to increase local proliferation while the epidermis is spared, although cooling is often required to ensure superficial protection.

The first to mention is the 532-nm KTP laser, which is safe and effective for improvement of acne (more so than scar treatment), thus aiding in prevention of acne sequelae such as scarring. The optimal nonablative laser to use for hypertrophic scars or keloids is the 585-nm pulsed dye laser (PDL). Best results and least side effects are obtained on Fitzpatrick skin types I or II because of less competition with melanin. This laser focuses on erythema and vascularity so incidental scar improvement is possibly because of decreasing vascularity (the scars are hyperemic because of angiogenesis) and its associated secondary effects in the local field or other cellular alterations, specifically regarding collagen. Improvement after use can be seen up to a year. Furthermore, it appear to have a role in the treatment of minor atrophic scarring.

As mentioned under vascular lasers in Grade 1 scarring above, other wavelengths such as the 1,064-nm long-pulsed and quality-switched laser have been successful in the nonablative treatment of acne scarring. The 1064-nm neodymium:YAG (Nd:YAG) laser demonstrates low pigment effect with higher vascular effect causing hemostasis and resultant infarctions within vessels. It could have effect similar to those just discussed for PDLs used on hypertrophic scars or keloids. However, repeated treatments are required. A minimal melanin absorption spectrum and deep papillary and mid reticular dermal treatment is achieved with the 1320-nm Nd:YAG laser. Those with a predominance of atrophic scars, defined as greater than 90% of scars present, improved the most with mixed scars next. Another laser variant or the 1450-nm diode. Efficient absorption is seen by water but minimally by melanin when using the 1540 Er:glass laser. The primary depth is within the papillary dermis where collagen tightening and neocollagenesis are achieved. Progressive improvement and long-term benefit after treatment with this modality. It states that outcomes are often gradual with increased dermal collagen seen in approximately 6 months after 4 successive treatments and continued improvement occurs several months after the session. These lasers use conducted heat from the chromophore to produce a diffuse dermal injury, heating to >50°C and inducing collagen remodeling.

Non Ablative Light Therapy (Intense Pulsed Light)

The next few therapies are not true lasers by definition but are more reliant on different energy forms to achieve their effect. The first is intense pulsed light (IPL). These machines emit a wide range of wavelengths from their source that can be precisely narrowed using wavelength filters. Other parameters such as pulse length, pulse delay, and joules can be adjusted also. All of these options, in combination, allow for tailoring therapy to a

defined goal. "IPL offers a therapeutic alternative to the gold standard PDL [for the treatment of hypertrophic scars. The Ellipse IPL treatment, directs well-controlled pulses of light into the upper skin layer. This works by attacking the vascularization of the scar. One treatment approach involves pre-treating the initial keloid elements with corticosteroid, followed by a course of short IPL emissions. A typical regimen includes up to four treatments spaced four weeks apart. This approach not only reduces the redness of the scar, but also stimulates collagen reorganization, thus reducing its size

Non Ablative Radiofrequency

Radiofrequency devices are another possible option for improving scars through stimulation of remodeling. A monopolar device uses a single contact location for the area of origin of the electric current. That current then diminishes as it flows to a remote grounding pad. A bipolar device has two local electrodes so there is not a path of current through the body. Physicians are able to treat variable skin types because this is electric energy use and not a chromophore-based intervention. It leads to tissue tightening and skin appearance improvement through dermal collagen denaturation with subsequent neocollagenesis and remodeling that there was qualitative improvement in underlying scarring. Nonablative radiofrequency for the treatment of moderate to severe acne (scar preventative treatment) noted, as an incidental result. **See later**

Volume Treatments

One can also use dermal fillers if the individual scars are deep enough, and flooding the dermis with superficial dermal fillers is also a possibility. Although superficial dermal fillers are unproven in scarring, they have a rejuvenating effect on skin elasticity and dermal thickness.

Grade 3 Moderate Scarring

Grade 3, or moderate disease, scarring involves **moderate atrophic or hypertrophic scarring** obvious at conversational distance. It incorporates rolling scarring and superficial box car scarring, In our facial reconstruction exemplar, this level of scarring includes all the features of this paradigm, including skin surface improvement , volume changes with filling agents, movement-related changes with neurotoxins particularly in the lower face and perioral area, and surgical options including subcision.

Surface Treatments

Surface treatments for this level of scarring include reasonably aggressive technique-driven resurfacing procedures, including ablative non fractional or fractional CO2 or erbium laser, nonablative fractional or non fractional energy based tehnology, such laser, light and radiofrequency ,minimally ablative plasma skin resurfacing, dermabrasion, and chemical peeling.

1. **Ablative CO2 Laser**

During the late 1990s and early 2000s, the gold standard for the treatment of facial lines and wrinkles as well as acne and traumatic scars was, at least from a laser

point of view, the carbon dioxide (CO_2) laser system. The CO2 laser emits a 10.600nm wavelength, which is strongly absorbed by tissue water. The penetration depth is dependent upon water content and independent from either melanin or hemoglobulin. The high-powered pulsed CO2 Laser (UltraPulse; Lumenis), Sharplan SilkTouch and FeatherTouch systems accomplish similar clinical results. This treatment is more aggressive and deeper than a chemical peel but remains at a specific depth of 20 to 30 um with thermal damage of 50 to 150 um. It is usually bloodless but still achieves total ablation of the epidermis and a portion of the dermis. In addition to the destructive nature, there may also be stimulation of collagen by the procedure. The usefulness is primarily for hypertrophic scars, boxcar scars (preferably shallow), and, less effectively, keloids. There are some who achieve fairly quick results, visible as soon as 2 weeks, but improvement because of the wound-healing phases continues for at least 18months. Downtime with the CO_2 laser typically lasted about one week or more, and depending on the device and the aggressiveness of the clinician utilizing the device, potential adverse effects became more widespread. Although traditional ablative laser resurfacing was able to achieve results for skin tightening, which rivaled surgical correction, the potential adverse effects included pain, edema, persistent erythema, infections, post-inflammatory hyperpigmentation, and the most problematic of all, hypopigmentation following the ablative procedure, seen in some patients two years following the laser surgery significantly limited the application of this technology.

2. Ablative Erbium YAG Laser

To counter these potential adverse events, the erbium:yttrium-aluminum-garnet (Er:YAG) laser was introduced. It emits a wavelength of 2940 nm in the infrared range, which is close to the absorption peak of water and yields an absorption coefficient 16 times that of the CO2 laser. This provides a more precise ablation of skin with minimal thermal damage to the surrounding tissue with minimal thermal damage to the surrounding tissues, resulting in less severe side effects and faster overall healing times. Downtime still may be from 5 to 7 days depending on the power utilized. Er:YAG lasers still can occur as well as other problems similar to those of the CO_2 laser. Again, this may be of benefit for hypertrophic scars, rarely keloids, and shallower boxcar scars.

Sciton's (Palo Alto, Calif.) ProFractional™ tunable resurfacing laser (TRL) utilizes an Er:YAG 2940 nm wavelength, which allows practitioners to adjust the depth of ablation and coagulation independently, enabling customized treatment depending on scar features such as thickness, prominence of the scar and target chromophores. Ablative full-face laser skin resurfacing has for nearly two decades been considered the criterion standard for the treatment of post-acne and other types of scarring but may be giving way to fractional devices.

3. Fractional Skin Laser Resurfacing (Non Ablative/Ablative)

The field of skin resurfacing has evolved rapidly over the past two decades from ablative lasers including CO2 and Er:YAG to non ablative systems employing near IR lasers, IPL, RF and ultrasound to Fractional photothermolysis (FP) or thermolysis (FT). Since its emergence 10 years ago, laser surgeons have been in a laser "resurfacing" renaissance. FT was developed as a way for laser surgeons to get closer to ablative laser resurfacing clinical outcomes with less patient downtime and fewer overall adverse events.

Simply stated, FT is the production of an injury pattern to the skin with skip areas repeated over and over again, which, as they heal, promote an improvement in the tone and texture of the skin, in lines and wrinkles, in pigmentary concerns including melasma, and in scars, especially acne and traumatic scars. The concept of fractional emission of light into microscopic zones of injury contrasts with traditional ablative skin resurfacing using a CO2 or erbium laser, in which a flat beam induces a confluent, uniform patch of epidermal or dermal injury. After a 48- to 72-hour phase of acute thermal damage, a phase of reepithelialization and repair starts, which is mediated by the adjacent columns of intact tissue. In this 30-day phase, the areas of thermally ablated tissue are repopulated by fibroblast-derived neocollagenesis and epidermal stem cell reproduction.

In more technical terms, small columns of thermal injury to the skin, are known as microthermal zones (MTZs). These MTZs vary from device to device. Some are nonablative dermal injuries only; whereas, others are associated with ablative changes in the skin, causing both epidermal and dermal injury patterns. MTZs also vary greatly in their diameter of affect and in the degree of depth they achieve to create the injury. Once injured, the skin begins a very rapid process of repair. The repair mechanisms seen in FT occur through the trans-epidermal delivery of treated necrotic skin into the stratum corneum, in which it is exfoliated away in a very short time period. This process, is known as microscopic epidermal necrotic debris (MENDs). MENDs is another term routinely associated with FT and appears unique to FT. The rapid healing process is made possible through the help of the surrounding "normal" or untreated skin—another process unique to FT. Based upon these mechanisms of action nonablative FP holds great promise in both treatment of skin textural abnormalities (acne scarring, rhytides, and skin mottling associated with photoaging) as well as pigmentary variation (melasma, hyperpigmented scars, lentigines, and dyschromia). One of the significant advantages of nonablative FP is the low incidence of adverse side effects.

Fractional thermolysis (FT) can be divided into several classifications. The easiest has been to classify FT devices into nonablative and ablative FT laser systems. This classification was "easy" at the beginning when only several devices were available. It is now a little more complex, especially among the ablative laser systems, thus new terminology seems prudent at this time. Ablative FT laser systems originally were divided into classifications based on laser type: CO_2, Er:YAG, or yttrium-scandium-gallium-garnet (YSGG, 2790nm). What has changed is that different ablative FT laser systems emit light differently, with penetration depths that may be considered "superficial" and others that may be considered "deep." Thus a new classification system seems prudent at this point. ablative FT lasers has been classified into "micro-ablative FT laser systems," which would include those lasers that produce epidermal and dermal damage to a depth less than 750 microns, and "deep dermal ablative FT laser systems," which would include those lasers that produce damage beyond 750 microns in the skin.

Non Ablative FP Lasers (NAFP)

Indications for nonablative FP include mild to moderate acne scarring; dyschromia; hypopigmented scars, fine wrinkling and texture changes associated with photoaging on the face, chest, neck, and hands. The non ablative FP systems include; Fraxel restore 1550nm, Fraxel refine 1410nm, Affirm 1440nm, StarLux 1540, Matisse 1540nm, Dermablate1540nm, Mosaic 1550nm and Sellas 1550nm. The nonablative devices produce minimal patient discomfort. Some patients may require a topical anesthetic prior to the

procedure and/or forced cool aircooling during the procedure. After treatment most patients notice erythema and some edema, which can last for up to 48 hours following the treatment, followed by skin desquamation for several more days. With all nonablative fractional devices, there is usually a need for multiple treatments to achieve the final result. Most contend that 4 to 6 treatments are required to attain the given desired outcome for the majority of clinical indications.

Ablative FT Lasers (AFP)

At first, the ablative FT devices were nothing more than "regular" CO_2 or Er:YAG devices with modified computer software programs, reduced spot sizes, and scanning devices that were tuned to provide skip areas. The first of these introduced was the Active FX (Lumenis Aesthetic), which utilizes the UltraPulse platform, considered by some to be the gold standard for ablative resurfacing. A second computer-generated spot size for the UltraPulse is known as the Deep FX. In order to achieve the best results with the Active FX and the Deep FX, many are now combining the two modalities, with the first pass being the Deep FX and the second pass the Active FX. Collectively, this has been termed "Total FX". Ablative Fractional carbon dioxide (CO2, 10,600 nm) photothermolysis such as Fraxel re:pair, Reliant DEKA Smartxide DOT Ellipse Juvia (Hørsholm, Denmark), Lasering USA Mixto SX, and Lutronic are now available.

The Er:YAG laser operates at a wavelength (2940 nm) where tissue water absorbs maximally. It is used for ablative skin rejuvenation, and therefore it was obvious also to utilize this laser in a fractionated manner for treating rhytids, fine lines and for skin resurfacing The Ablative fractionated Er:YAG laser (2,940 nm) (Pixel, Alma Lasers) was designed to overcome the homogenous pattern of thermal damage created using standard erbium-doped yttrium aluminum garnet (Er:YAG) by creating microscopic thermal zones (MTZs) with sparing of tissue surrounding each wound.

The degree of improvement with ablative fractionated resurfacing significantly surpasses that of the nonablative fractionated devices, with only slightly longer downtimes and similar low side effect profiles. Furthermore, the rapid recovery times seen with fractionated CO2 laser marks a significant improvement over traditional CO2 and Er : Yag laser resurfacing because of the differences in mechanisms of wound healing. Traditional ablative laser wounds heal by migration of stem cells from hair follicles. In contrast, with fractional ablative resurfacing, re-epithelialization occurs more rapidly because of migration of neighboring cutaneous stem cells. This mode of resurfacing produces improvements is analogous to that only previously achievable with traditional ablative resurfacing or even greater because of the pattern of thermal ablation, which provides deep dermal penetration not be achieved safely with traditional ablative devices. In addition, the efficacy of ablative FP (AFP) in the treatment of moderate to severe acne scarring is confirmed.

4. Ablative Plasma Skin Resurfacing

A newer form of energy treatment used in skin remodeling is plasma. Plasma pulses are created by passing ultrahigh radiofrequency energy through inert nitrogen gas, leading to stripping of electrons and formation of the ionized gas (Plasma Cloud).

The energy is then directed to the patient's skin surface by the handpiece. No specific chromophore is targeted but the energy causes dermal collagen denaturation and stimulates neocollagenesis with minimal side effects. It does not vaporize tissue but leaves a layer of intact, although denatured epidermis, which acts as a natural dressing favoring accelerated wound healing. Unlike with nonablative resurfacing, the epidermis is destroyed and is shed when healing completes after approximately 1 week. Results appear to be similar to gentle CO2 and Er:YAG laser resurfacing. The more aggressive the treatment—that is, the higher the fluence—the more impressive the results.

5. **Dermabrasion**

Arguably one of the most effective but operator dependent therapies is dermabrasion. Its benefits include removal of the skin surface and refined contouring of scars. Dermabrasion was the first major advance in the treatment of atrophic and traumatic scarring. It is probably at its best in treating grade 3 rolling scarring and will tighten the skin somewhat in older patient with scarring. The sharp edges of some acne scars cast a shadow that emphasizes the lesions contouring reduces these contrasts, lessening their visible impact. Essential removal of superficial scars can be achieved along with a reduction of deeper scars. In addition, it may be used as an adjunct to the surgical procedures such as punch elevation or grafting. Dermabrasion has remained fairly constant in technique for more than 100 years apart from some refinements in patient selection and end pieces. More recently, literature on abrasive treatment has centered on additional cosmetic uses and appropriate anaesthesia for this procedure.

6. Chemical Peeling

For patients with more-severe scarring, deeper peels are usually employed. The medium-depth peels are primarily considered to be the 10% to 40% TCA solutions. It is a safe and effective modality in dark-skinned patients for the treatment of post acne scarring. It has also been combined with dermabrasion to increase efficacy and is said to decrease postoperative pain and complications. As with any resurfacing procedure, a proportion of patients will develop post-inflammatory hyperpigmentation. Chemical peeling is cost effective, and where expensive recurrent laser technologies do not exist or are not practical, it is a reasonable alternative resurfacing technique.

7. Radiofrequency (RF)

A) Non Ablative Radiofrequency (NARF)

Radiofrequency devices utilize electrical energy to transfer heat energy to the dermis at relatively low temperatures. These devices typically are not intended to resurface the skin but rather to induce thermal damage to dermal collagen while sparing the epidermis. Resistance and the resultant degree of thermal damage is determined by the depth and composition of the treated tissue. When applied over a period of time, thermal energy contracts and thickens collagen fibers, disrupts hydrogen bonds, and alters the conformation of the collagen triple helix. It also induces a more prolonged

wound-healing effect that is associated with sustained remodeling, reorientation, and formation of new collagen bundles over subsequent months, resulting in effective skin tightenin with minimal recovery time. The collagen-based fibrous septa that separate fat lobules in the subcutaneous tissue are also preferentially heated, leading to further collagen denaturation and contraction of the subcutaneous tissue and accounting for the immediate tightening and lifting effect on the skin. Because RF energy uses an electrical current rather than a light source, it does not affect epidermal melanin; therefore, patients of all skin types, including darker skin types and those with a predisposition to develop post-inflammatory hyperpigmentation may be treated with RF. Everybody is a good candidate for RF, but it is of special significance to whom do not like invasive surgical intervention, and who is still young for surgery. Contraindications include implantable medical devices such as pacemakers and defibrillators and active dermatologic conditions such as collagen vascular disease and autoimmune diseases.

MONOPOLAR Radiofrequency (RF)

Monopolar systems deliver current using one electrode that contacts the skin and another that acts as a grounding pad. The electrode contacting the skin delivers the electric current to the skin. The epidermis is spared by applying a cooling while the dermis is heated uniformly and volumetrically. Aside from rhytides reduction, successful treatment of moderate to severe cystic acne, acne scarring, and cellulite have been reported. The use of larger, faster tips, lower energy levels and multiple passes has diminished associated pain but not eliminated it. The low level multiple passes approach necessitate 4-6 sessions every one to two weeks. The procedure can be repeated every one year as needed to maintain the results.

Bipolar RF

The main difference between bipolar and monopolar RF is the configuration. The monopolar RF devices have one active electrode placed on the skin and a grounding electrode. The bipolar configuration consists of two active electrodes placed a short distance apart overlying the intended treatment area. The current flows between the two electrodes. The depth of penetration is approximately half the distance between the two electrodes. The major limitations of the bipolar RF devices seem to be depth of penetration. The mechanism of action for simple bipolar RF devices is similar to that of monopolar RF devices.

Combination with light devices has been used to overcome this limitation Bipolar RF devices are frequently combined with light-based technologies, termed **electro-optical synergy (ELOS).** The **ELOS** system uses the synergistic effects of lightand RF-based devices. The light energy is used to preheat the target tissue through photothermolysis, which lowers the tissue's impedance. The lower impedance makes the tissue more susceptible to the RF component so that it is selectively targeted. Therefore, lower levels of energy of the light and RF component are needed to produce the desired effect with fewer side effects. The optical component also targets fibroblasts, blood

vessels, and dyschromias. The most widely used ELOS systems are those that use intense pulsed light (IPL), a diode laser, or infrared light. RF devices the Polaris™ and ReFirme™ from Syneron™ utilize bipolar RF at the ends of laser systems (780–910nm diode for the Polaris and 700–2000nm infrared light for the ReFirme™. A major drawback of this therapy, however, is that it requires numerous treatments at 2- to3-week intervals, which may ultimately achieve only mild to moderate improvement.

Functional Aspiration Controlled Electrothermal Stimulation(FACES) is another system used with the bipolar device that uses a vacuum to maximize and control penetration of the electric current. The vacuum is used to fold the skin to a predetermined depth, which allows for closer alignment and deeper penetration with the RF energy than with traditional monopolar and bipolar devices. The volume of treated tissue is limited to that located between the electrodes in the special vacuum tip, so lower energy levels can be used to meet the energy density needed to reach and affect the chosen skin layers, leading to greater efficacy, less pain, and lower incidence of side effects. Although the combination systems are better tolerated than the monopolar RF systems, topical anesthetic creams may be used at the physician's discretion to alleviate any associated pain. FACES-based devices (e.g., Aluma System Lumenis) are composed of an RF generator, a handpiece, and a tip with two parallel electrodes. Modest results have been reported regarding the efficacy of the ELOS systems for and FACES in facial laxity, acne, scars, vascular and pigmented lesions, hair removal and cellulite.

Non Ablative Fractional Radiofrequency(NAFRF)

Fractional RF is a newer nonablative approach. There are two ways to deliver fractional RF. Whereas some devices (Matrix RF device; Syneron, Medical Ltd) use electrodes, others use an array of microneedles arranged in pairs between which bipolar RF energy is delivered (ePrime system; Syneron Medical Ltd). Another system Miratone FRF system (Primaeva Medical, Inc.,Pleasanton, CA) using a microneedle electrodearray. The fractionally delivered energy creates zones of affected skin adjacent to unaffected areas. The treated areas have resulting thermal damage in the deep dermal collagen, which stimulates would healing, dermal remodeling and new collagen, elastin, and hyaluronic acid formation. The unaffected areas located in between affected areas initially maintain skin integrity but, in the long term, serve as a reservoir of cells that promote and accelerate wound healing. A new device has been developed that combines fractionated optical energy with a 915-nm diode with a fractionated bipolar RF. This integrated system targets the epidermis and superficial dermis. By using the RF component synergistically, less energy is used to heat the collagen in the deep dermis and stimulate new collagen formation and contraction (Matrix eLaser; Syneron,). This device has been associated with significant improvement in acne scarring, texture, and pigmentation. It appears that NAFRF devices are a safe, tolerable, and effective modality for wrinkle, acne scars and facial laxity reduction. The most common side effects are erythema and edema, which are transient, and patient discomfort does not seem to be a major disadvantage. A topical anesthetic cream may be used before treatment to minimize pain.

Volume-Related Treatments

While the goal in treating hypertrophic Scarring is to Decrease volume by steroids or cytotoxics, we need to increase volume in atrophic scarring using soft tissue augmentation.

Decrease Volume

Intralesional Corticosteroids

The glucocorticoids (triamcinolone, hydrocortisone, methylprednisone, and dexamethasone), in the corticosteroid family, have immunomodulatory and anti-inflammatory properties. They reduce the expression of cytokines, cellular adhesion molecules, and other enzymes related to the inflammatory process. The exact mechanism is unknown but it is thought to related directly to the anti-inflammatory properties, reduction of collagen, glycosaminoglycans, and fibroblasts, along with overall lesion growth retardation. Intralesional corticosteroid injections have become a mainstay in the treatment of hypertrophic scar and keloids, alone or in combination with other therapeutic procedures. Corticosteroid application can soften and flatten keloids but cannot narrow hypertrophic scars or eliminate keloids. We recommend beginning with direct serial intralesional corticosteroid injections in an already developing keloid or hypertrophic scar. The most commonly used drug for steroid injection is triamcinolone acetonide (TA) at a dose of 5 to 10 mg/mL, which should be injected with a 25- to 27-gauge needle into the upper dermis of a developing hypertrophic scar every 3 to 6 weeks. Injections are discontinued when the scar is stable, when surgical intervention is indispensable, or if side effects such as tissue atrophy, hypopigmentation or telangiectasia develop. The treatment of preexisting keloids should begin with three monthly, intralesional injections of TA at a dose of 40 mg/mL mixed with equal parts of 2% lidocaine. Some authors also recommend the addition of hyaluronidase, which helps to disperse the injection. Because tissue absorption through intact or sutured skin is poor, the use of topical steroids is indicated only for superficial lesions, such as those occurring from dermabrasion.

Intralesional cytotoxics, including fluorouracil, bleomycin, and mitomycin, are used as treatments for hypertrophic and keloidal scars. Fluorouracil can be used at a concentration of 50 mg/mL and has been mixed 80:20 with low-strength intralesional steroid , although it may also be used alone, with approximately 1 mL used in each scar

Movement-Related Treatments (Botox)

Scarring occasionally occurs in areas that are subject to recurrent movement. This may be less obvious when one is young and the tissues more able to resist the movement through the flexibility and springiness of the dermis and the subcutaneous volume overlying the muscle action. However, with aging, there develops a combination of events such as photodamage, recurrent facial habits (smoking, elocution), and loss of volume that combine to make tissues naturally unable to resist the underlying muscular forces. This allows static wrinkles and lines to develop. If one is scarred, particularly if this scarring is atrophic or mildly hypertrophic, normal muscle movement may have an exaggerated effect because of volume loss from past acne activity and loss of dermal flexibility with scarring. This seems to be particularly true of grade 3 rolling atrophic scarring. In such areas, botulinum toxin

may be used. Although botulinum toxin has a role in the treatment of scars in the upper face, especially when scars are present in the glabella or forehead regions, this is of particular importance in the lower face, where the marionette lines and chin are the two most commonly affected areas. Botulinum toxin may be combined with fillers, although the fillers are usually administered at a later session, once the effect of the botulinum is established. The use of dermal fillers and botulinum appears to be synergistic in many cases

Surgery-Related Treatments

Surgery is sometimes done for debulking hypertrophic or keloidal scare followed by multiple modality treatment such as intralesional steroids to prevent recurrences. Aggressive scars have a regrowth of 50% to 100%. For atrophic acne scars subcision works by breaking up the attachments, releasing the surface from the deeper structures**.**

Subcision

A tri-bevel needle is probed under the lesion through the needle's puncture so it is not a true incision. This movement results in the releasing of papillary skin from the binding connections of the deeper tissues and creates controlled trauma that leads to wound healing and associated additional connective tissue formation in the treated location. It may be necessary to perform variable depths of sweeping, fanning, or lancing to disrupt the fibrous connections. Intradermal insertion is suitable for small superficial scars, whereas deeper dermal undermining is performed for more-severely bound down scars. It has become a first-line treatment for many isolated, moderately bound down, atrophic scars. A combination of subcision and nonablative laser suggested a synergistic effect between these modalities. Multiple attempts or sessions may be required.

Medical Treatment

Silicone Dressing

Another treatment modality used that focuses on hypertrophic scars and to lesser degree keloid is silicone dressing. There is variable support to the silicone itself, with results more likely attributable to occlusion or hydration. Pressure was also one supported mechanism along with other rationales that include temperature, increased oxygen tension, electrostatic properties, or immunologic effects. Although the mechanism of action of silicone elastomer sheeting has not been completely elucidated, it appears to be an effective means of treating and preventing hypertrophic and keloid scars.

Platelet Rich Plasma (PRP)

Platelet-rich plasma (PRP) is used to improve healing of ablative fractional resurfacing wounds. Autologous Platelet Rich Plasma, uses platelets prepared from the patient's own blood to support and accelerate hard and soft tissue regeneration. As vehicles for controlled delivery of growth factors, platelets are injected into the dermis where they induce proliferation of fibroblasts, promote the production of new collagen and other extracellular matrix components, stimulate stem cell migration proliferation and differentiation, and improve micro-vascularization.

Grade 4 Scarring (Severe Scarring)

Grade 4 post acne scarring is usually non distensible and includes severe atrophic or hypertrophic scarring obvious at conversational distance and not able to be flattened by manual stretching of the skin. This grading incorporates deep box scarring and ice pick scarring, as well as deep lumps and more-severe or -widespread hypertrophic scarring. The facial reconstruction paradigm again involves all aspects including:

Skin Surface

Technique-specific resurfacing (lasers, dermabrasion, strong chemical peeling) or the CROSS technique for ice pick scarring may be useful.

CROSS Technique (Chemical Reconstruction of Skin Scars)

Application of TCA to the skin causes cellular necrosis of the epidermis and necrosis of collagen in the papillary and reticular dermis. A variation of chemical peeling involving the use of 60% to 100% trichloroacetic acid, termed the CROSS technique, has raised interest in the treatment of smaller ice pick and boxcar type scars, which have always proved a challenge. Basically, this modality scars the inside of the already cylindrical scar, making it cosmetically more appealing. A similar concept has been discussed with the use of high-energy CO2 laser. After 3 to 6 treatments, 90% of patients showed good (50%-70%) improvement. The peels considered to be deep are often phenol (carbolic acid) or croton oil based. These can certainly be more effective but carry an even greater potential for side effects.

Volume Change Correction (Soft Tissue Augmentation)

Volume change correction includes focal dermal filling of individual scars and volume fillers (e.g., fat transfer, off-the-shelf fillers such as hyaluronic acid (HA), polylactic acid, and hydroxyapatite. Potential superficial skin products may include collagen or hyaluronic acid and deep skin products include fat, synthetics, silicone, implants, and permanents. An ideal filler material would be physiologic (incorporates into the body's tissues), simple to place(injection), permanent (no degradation), and risk free (no complications or side effects). Most of these are applicable to depressed scars such as the atrophic rolling variant or sometimes others.

Focal Non-autologous Tissue Augmentation

Collagen

For patients with few atrophic scars, there is an array of injectable fillers, including human collagen and HA (although collagen is giving way to HA) among the short-term agents. The first injectable filler approved by the FDA was **Zyderm.** The other similar products are **Zyderm II and Zyplast**. These collagen products are derived from a closed US bovine herd. Even though this helps to ensure quality, purity, and safety, its immunologic basis is not effected, therefore, skin tests are still required. Type I collagen represents 95% to 99% and type III collagen represents 1% to 5% of the product contained in prefilled syringes.

ArteFill or Artecoll are 20-volume percent suspensions of 30 to 50 um diameter microspheres of polymethyl-methacrylate in 3.5% collagen solution, saline, and lidocaine. The polymethyl-methacrylate is permanently deposited and encapsulated with fibrous tissue after injection while the remaining collagen is gradually resorbed. Both serve physical augmentation and scar stimulus functions. As noted above, skin

testing is required because it is from a bovine source. To reduce the allergic reactions of bovine collagen, human collagen fillers were later developed and marketed **as CosmoDerm™ I) and CosmoPlast**™. All five products typically last three to five months in tissue and all contain lidocaine to minimize pain during treatment.

Hayluronic Acid

Hayluronic acid has a chemical structure similar in some ways to sugar, and is identical in all species and in all tissue types Hyaluronic acid is a natural component of human skin and is the framework in which skin cells live. It also plays an important role giving volume to the skin, shape to the eyes and elasticity to the joints. Several products are available for clinical use for correction of soft tissue contour deficiencies such as wrinkles and folds. All hyaluronic acid products bind water and give the skin volume. Fillers include hyaluronic acid (HA)-based products with varying degrees of cross-linking. These HA products have themselves been shown to stimulate endogenous collagen formation over time, which could contribute to sustained volumetric correction of treated scars. Although hyaluronic acid fillers such Restylane,Hylaform,Hylaform Plus,Captique Restylane, FineLine, and Perlane,Hyacel,Juvederm, Hydrafill, Surgiderm, Surgilips,Achyal, Hyal2000, Hylan SES,Matredur, Rofilan Esthelis Viscontour and others are the most commonly used fillers worldwide and have an excellent safety record, their use is not without risk. Aan awareness of existing treatment algorithms is needed to manage potential complications.

Other Filling and Augmentation Agents

Silicone,'' a term consisting of polymers in the family of the element silicon, most commonly polydimethylsiloxane(silicon, oxygen, methane), is a permanent injectable. It is safe, non mutagenic, non carcinogenic, and non teratogenic despite scattered case reports of adverse events. The mechanism of action is from physical filling of connective tissue defects and possible production of fibrotic collagen that encapsulates the injected material (a foreign body) preventing migration. Final results could take months while the collagen is deposited and remodels. In addition, it is not altered, metabolized, or destroyed by the human body. Considering all of these facts, under correction is often prudent initially. Silicone is not a growth media for bacteria or other organisms and no true allergies have been reported, so skin tests are not required before use. With any mention of silicone, there will always be those concerned with safety and who argue against its use. There are several silicone products that are available, with the usual difference based on viscosity. The original silicone was 350-centistoke viscosity. **Adatosil 5000** is medical-grade silicone of 5000- centistoke viscosity and **Silikon 1000** is of 1000- centistoke viscosity. Polydimethylsiloxane gel is a silicone oil with viscosities from 350 to 5000 centistokes and another is Silskin. One that is slightly different from these is **Bioplastique**. It consists of solid silicone particles (100-400 and 600 _m) suspended in polyvinylpyrrolidone gel. There is gradual replacement of the gel with fibrous tissue and native collagen.

Dermalive is a 60% hyaluronic acid plus 40% acrylate suspension of 45 to 65 um, irregularly shaped hydroxyethyl methacrylate and ethyl methacrylate particles. Injections are to be done every 3 months to desired effect with approximately 40% retention of each treatment. No skin testing is required prior. **Dermadeep** is the same composition as Dermalive but the acrylate crystals are larger, 80 to 110 um.

Polyacrylamides compose yet another form of injectable augmentation products and, once again, several products exist. Outline is composed of absorbable hydrophilic polyacrylamide gel particle that are positively charged, thus attracting negatively charged glycosaminoglycans already in the skin such as hyaluronic acid. Similarly, Evolution, positively charged polyvinyl microspheres in hydrophilic gel, also attracts the negatively charged molecules. **Bio- Alcamid** is a polyalkylimide gel that is 96% water and 4% synthetic polymer that stimulates a fibrous response after injection**. Agriform** is a 5% water and 95% hydrophilic polyacrylamide gel combination, in contrast **to Aquamid**, a 97.5% water and 2.5% hydrophilic polyacrylamide gel mixture.

The polylactic acids are a more recent addition to the treatment options available for injection to scars. Previously, these materials were used in suture materials and other treatments. **NewFill**, the primary brand for Europe, was available in 1999, as freeze dried polylactic acid available for reconstitution with water. Poly-L-lactic acid was rebranded in the United States in 2000 as **Sculptra**. It is thought to stimulate neocollagenesis over 3 to 6 months and is for long-term augmentation. Side effects are possibly worsened by excess injection material, inadequate duration between injections, or multiple single-session injections. No skin tests are necessary with the use of polylactic acids.

Radiesse contains 25 to 45um diameter calcium hydroxyapatite microspheres in polysaccharide (carboxymethylcellulose) aqueous gel. It is categorized as ''semi-permanent'' with earlier claimed durations of 2 to 5 years, but more recent estimates of a year to 16 months. There is little inflammation or side-effect profile and no allergy testing is required.

Reviderm Intra consists of 40- to 60-um Sephadex (dextran) beads suspended in bacterial-derived hyaluronic acid. It stimulates inflammation and neocollagenesis. **ProFill** is a polyoxyethylene and polyoxypropylene polymer forming an injectable gel that must be refrigerated as a liquid until used. Skin testing is not necessary.

Fibrel is patient plasma that is mixed with porcine gelatin plus epsilon-aminocaproic acid and lidocaine. It serves as a physical filler and a media for neocollagenesis. This product requires a patient blood draw and may be more painful on injection or lead to a local inflammatory response

Fat Transfer,Fat Injections, Fat Grafting, Micro-Lipoinjection, Autologus Fat Grafting

For severely atrophic disease in which there is destruction of the deeper tissues, fat remains the optimal replacement agent, first noted in 1893, to improve acne scars. The word autologous means material (fat) is harvested from one area and donated to another in the same individual. Although fat transplantation has been utilized in medicine for more than 100 years, the concept of injecting human fat back into the patient as an effective means to fill in wrinkles and loss of tissue throughout the body and face has been popular only since the mid1980s. Autologous fat grafting meets all of the fundamental criteria of ideal augmentation materials: availability, low antigenicity, minimal donor morbidity, reproducible, predictable results, and avoids non-auto graft disease transmission or incompatibility, not likely to illicit immune

response, least reported complications and longer survivability. Considering these facts, autologous fat transfer provides a very appealing resource for soft tissue volume augmentation.

Fat is not considered generally effective for individual bound down ice pick scars. However once the scar is freed, fat may be satisfactorily injected. For widespread grossly atrophic disease in combination with deeper tissue destruction, fat should be considered as the optimal filling and volumizing agent . Fat is an excellent deeper augmenting injectable in acne scars. When higher volumes are required, fat injections can considerably save costs for the patient. Fat can be combined with other resurfacing techniques.

Any volumization should be performed first. While patients in the teens and early 20s may infrequently require volumizing, most patients that are older do need the enhanced volume. Volumizing smoothes and rounds the overall facial contour which reduces shadowing.. But the importance of overall facial volumizing is that a rounded facial contour has relatively the same shadowing in most head positions.
Issues of permanence are gradually being resolved. Fat no longer appears to be as temporary as initially considered. Accurate long lasting autologous corrections can result. Various factors may contribute to fat cell survival: harvesting method, manipulation of fat, exposure to blood or lidocaine, recipient site, donor site, centrifugation, injection method including syringe and needle size and overcorrection. Fat should be injected deeply as a three dimensional lattice with0.1–0.2-mL aliquots. The site is gradually built up to enhance the superficial layers in a lipo layering technique. Approximately 50% of transplanted fat should be expected to survive. Thus touch up procedures at 3 months may be needed. Overcorrection of about 10% is usually needed. Post operative care usually only requires antibiotic application to the injection sites. Post operative pain is minimal, and oral antibiotics are not required in the author's experience. Significant edema can be treated with a short course of oral steroids.

The next step involves micro lipo injection of the individual scars. Fat will not normalize the contour unless the residual scar attachments are destroyed first. Subcision as described above is done initially. Because of the small fat volumes utilized, centrifuged fat will be more concentrated. When injecting under small scars, the injections should be performed with the surgeon's choice of the smallest effective needle to allow accurate micro droplet infusion. Injections can be in any tissue plane as determined by the subcision, or within all three (intra dermal, sub dermal and subcutaneous) tissue planes. Only micro droplets are usually needed for intra dermal or immediate sub dermal placement. Often infusion is best accomplished as the needle is withdrawn. The endpoint is a slight over correction. Although, microinjecting fat intralesionally within the scar after subcision, Prof Moawad still recommends instilling at least a small amount underneath to volumize the area. This helps to stretch or distend some scars making them more superficial in appearance

As with lipofilling of cosmetic defects, the procedure should be considered as a multi treatment program. Small volumes are required even if multiple scars are infused, and as such the use of frozen fat aliquots from a single harvesting will save considerable time with future injection sessions. Fat can be stored in disposable syringes for up to one year or more, without contamination or deterioration in its ability to survive. Frozen fat is a way to gradually improve the patient and avoid a long initial downtime. It also affords the chance to "touch up" areas where the fat

may have dissipated or been under-corrected. The best of all is fat grafting is forgivable while the mistake of permanent filler is permanent!!! ," Prof Moawad says. The only relative drawback of fat injection has been the resoption of some of the fat graft. However, with proper technique, approximately 30–70% of the fat is retained Prof Moawad says. In my opinion the Disputes about longevity and the technique variation has postponed the announcement of fat as the perfect filler, added Prof. Moawad. The recent advances in fat grafting includes, plasma rich platelets (PRP), adipose tissue derived stem cells (ADCs) or collagenase digest fat shows great promise with prolongation of fat graft.

Movement Treatment

When treating scars by excision, neurotoxins may be used in a prophylactic method of scar minimization to aid in optimum healing. Neurotoxins such as botulinum toxin A may be used in this level of scarring, often as an adjunct to surgery for acne scarring, such as cyst, scar, or sinus tract excision. Botulinum toxin may be useful to decrease tension produced by muscular forces surrounding the scar. In addition to botulinum toxin's direct effect on reducing muscular activity, there also appears to be an inhibitory effect of botulinum toxin itself on fibroblasts, offering another potential mechanism for producing a more-satisfactory outcome for problematic scar revision and lesion removal.

Surgical Options

Surgical management is an essential tool in the armamentarium against acne scarring. The icepick, boxcar, and rolling scars are frequently addressed by surgery Surgical options include punch techniques and excision of severely dystrophic scars. Many scars are not amenable to pure resurfacing procedures, including scars with a white atrophic base, sharply punched out ice pick scars, and some chicken pox and post herpetic scars, which are more amenable to punch removal techniques such as punch excision, punch elevation, and punch replacement. A scar ''requiring a punch larger than 3.5 mm is repaired by elliptical excision or punch elevation because these larger defects lend to 'dog ear' formation on the face.''The goal is to trade a larger, deeper scar for a smaller, linear closure that will hopefully be less noticeable and possibly fade with time. Rarely, a **skin graft** may be required rather than primary closure. This usually only applies if a sinus tract or wide-based lesion is unroofed.

Punch excision removes a pitted scar using a straight-walled disposable or hair transplant punch that is slightly larger than the scar. Sutures are then placed to oppose the wound, as a normal excision. Punch replacement grafting, which has been used for several decades in dermatology , is probably best used to treat sharp-walled or deep ice pick scars with dystrophic or white bases. Resurfacing may be performed 4–8 weeks later to flatten the grafts and further blur the margins.

Punch elevation is a variation of other punch techniques, except that the scar is not discarded. The tissue cylinder is incised down to the level of the subcutaneous fat, and the scar is allowed to float up until it reaches the same level as the surrounding skin. A small piece of surgical tape initially holds the cylinder of tissue is held in position while the patient's serum fixes it in place, so sutures are not required. Resurfacing can be performed 4–8 weeks later if required. Punch excision, grafting, elevation, and float techniques have been useful and remain the criterion

standard for punched out scars up to 4 mm wide (deep box car and large ice pick scars).

Excision

Excision is usually performed in the context of severely atrophic facial scars or hypertrophic scars, often before resurfacing, to improve the overall result. It is usually decided early in the treatment planning process when a scar or scars are identified as severely dystrophic, tunneled, or just not likely to be improved sufficiently using resurfacing procedures alone. It is often easier to produce a scar and resurface it than to work with the original scar. Cautions for excision include underlying cysts, which are often worth treating first, and the usual rules of surgery regarding tension lines, cosmetic boundaries, and free margins apply. Serial excision and flaps should be something to consider in the treatment of most patients who require excisional work. As noted above, botulinum toxin could be added to the operative surgical armamentarium along with consideration of postoperative dermabrasion, ablative laser resurfacing, flash pump dye laser, and possibly fractionated ablative laser.

Hair Transplantation (FUE)

For hair transplantation, follicular unit hair extraction\and transplantation (FUE) method is used. We extracted follicular units from the beard instead of scalp, so that the texture, color, and thickness of transplanted hairs remain same as that of surrounding beard hairs. hair transplantation for acne scars in beard area in males is an innovative, less time consuming, relatively less expensive technique, which can be performed in a single sitting without any post procedure side effects. By this technique, one can almost achieve patient's expectation of non visibility of acne scars.

B: Other Scars Types and Their Revisions

Cutaneous scars are results of prior surgery trauma, or inflammatory processes, eg, acne. The scar may be cosmetically distressing or may cause distortion of functional anatomy. Thus, the objective of scar revision is the achievement of an aesthetically pleasing or less visible scar. Various techniques both surgical and nonsurgical, are available for revision of cutaneous scars (Table 1). Knowledge and experience in utilization of these techniques are necessary in order to achieve desirable results. Scars can be categorized by various descriptive characteristics including: contour, shape, length, width, color and function. Recognition and analysis of these unique characteristics along with the scars' location and position will aid in determining the appropriate technique or combination of techniques in revising a given scar. Scar revision is aimed at improvement of scars of either cosmetic or functional impairment. Numerous revision procedures are available for correction of the various types of scars. No one treatment or procedure is effective in correcting all types of scars. Therefore, knowledge and understanding as well as experience in utilization of the variety of techniques is vital in order to achieve acceptable results.

The Elevated Scar

Elevated scars can be caused by closure of wounds under tension or due to apposition of wound edges at varying levels causing a step-off deformity. Full-thickness grafts may also

leave an elevated scar in the reconstruction site. Dermabrasion is a highly effective procedure in effacement of elevated scars. It is advisable to notify the patient even prior to original surgery that a dermabrasion may be needed. The optimal time for performing the procedure is approximately 8 weeks post-surgery. These scars usually respond well to injections of intralesional steroids. Triamcinolone acetonide at a dosage of 10-40mg/cc is injected directly into the scars at intervals of 3-4 weeks. Care must be taken not to inject beyond the scar with resulting dermal atrophy, telangiectasias and hypopigmentation. In some instances improvement can be achieved by excision of the scar in fusiform fashion with care to reduce undue tension by placing the excision in the direction of relaxed skin tension lines, undermining, placement of buried absorbable intradermal sutures, as well as meticulous apposition of wound edges. Additionally, planning of the elevated scar with a scalpel or razor blade has been used for flattening of elevated scars

The Depressed Scar

Depressed or indented scars may result from performing a deep shave biopsy, curettage and electrodesiccation, suturing wounds with deficient wound eversion, or healing wounds complicated by formation of hematomas or infection. A simple fusiform excision with attention to wound eversion can correct the indentation in the majority of these cases. Wound eversion can be accomplished by using buried vertical mattress intradermal sutures and cutaneous sutures placed 90 degrees to skin surface with eversion of opposing skin edges with the aid of a skin hook or forceps. Cutaneous vertical mattress sutures can also help in achieving good wound eversion, however, they may leave unsightly suture marks. Soft tissue augmentation employing injectable autologous fat, or other above mentioned dermal fillers can elevate depressed scars.

The Widened Scar

Widened or spread scars occur with time in wounds closed under tension. They often form on the back, chest, or scalp areas. The scar can be excised, if possible parallel to direction of the relaxed skin tension lines, widely undermined, and sutured with buried intra-dermal sutures. Some advocate placement of nonabsorbable buried sutures such as nylon or polypropylene. Permanent anchoring or tethering sutures placed to the underlying periosteum or perichondrium may also decrease the chance for subsequent scar spreading.

The Long Linear Scar

Several techniques have been utilized to break up the appearance of a long unsightly linear scar. The rationale behind these techniques is that a scar comprised of multiple small scars is less perceptible than one long scar. W-plasty or geometric broken line closures are designed as a series of “W”s or unpredictable geometric figures advanced to interdigitate with a similar pattern on the opposite side of the scar. These procedures, however, are time consuming to construct and execute with proper wound approximation and can worsen a scars appearance. Dermabrasion may be an easier technique to execute that gives better and more consistent results. At times a re-excision should be performed followed by dermabrasion.

The Trapdoored Scar

Trapdooring (or pincushioning) usually occurs following reconstruction of deep defects with round-shaped or island pedicle flaps. Underlying wound contraction seems to cause

elevation of the center and depression of flap edges. The chances of trap dooring can be minimized if the flap is adequately thinned and placed flat in defect following wide undermining. Treatment of trap dooring consists of injections of intralesional steroids and if necessary incision along flap scar line and removal of underlying scar tissue with wide undermining. Dermabrasion using a motor-driven abrader or performed by manual dermabrasion will achieve improved cosmesis as well.

The Contracted Scar

Scars transversing concavities may contract and result in painful unsightly scars. This can be ususally prevented by designing the incision to be sinuous rather than a straight line. By using multiple Z-plasties it is possible to elongate, irregularize and flatten the contracted surgical scar. Z-plasty, one of the original techniques employed in scar revision, is basically a transposition flap in which equal-size triangular flaps (two or more) are transposed. The main indications for its use are: increasing scar length, effacing and elongating tight contracted scars, changing directions of scars, effacing webbed scars or shifting malpositioned facial landmarks. When used to lengthen a contracted scar the degree of lengthening can be controlled by the alteration of the angles of the transposition flaps. The greater the angle the greater the degree of lengthening.

The Webbed Scar

As mentioned above, scars transversing concavities can contract to form a short straight line. When it occurs in the inner canthal area the result is a tented or webbed deformity. Revision utilizing one or moe Z-plasties, as described above, can repair the defect by changing the direct of tension on the scar with effacement of the webbing.

Distortion of Free Margins

Following reconstruction with flaps or grafts a resulting scar may contract against a free structure such as the vermillion border ensuing eclabian. The lower lid can also be pulled down by scar contracture causing ectropion. Two or more small 60 degree Z-plasties are helpful to lengthen the scar and allow the pulled free vermillion border to return to its normal position.

Repair of ectropion of the lower lid is corrected with a full-thickness skin graft. Incision is made in lower lid and placed as high as possible under the lash line. The graft is sutured into position and traction is placed on the graft with intermarginal sutures (or Frost sutures). These sutures are left in place for 1 week to allow healing of graft in the maximally expanded state. In a few cases the skin grafting is combined with a horizontal tightening procedure as the skin replacement alone will not restore the lid to its original position.

The Notched Nostril

Various techniques can be used for repair of pulling up or notching of the nostril or alar rim. Distortion or notching of the ala can follow nasal reconstruction. Time alone may allow enought scar relaxation for the ala to return to its normal position. Intralesional steroids can hasten the process. If, after 6-9 months, the ala has not resumed its normal position, one of the various revision techniques should be considered. A Z-plasty or the use of multiple convergent triangle flaps can shift the nostril base forward to the level of the alar margin. Convergent triangle flaps are equivalent to multiple Z-plasties but easier to execute and

suture. Notching can also be corrected by utilizing a composite graft, harvested from the helix, anthelix, anterior crus, or tragus, which is trimmed and sutured in place. For large alar defects a hinge flap can be created from the skin immediately superior to the defect and serve as the inner lining over which a composite graft will be placed. A two-stage pedicle flap may be used from the nasolabial fold. The flap is turned on itself to provide an inner lining and the pedicle is severed after 3 weeks.

Timing of Scar Revision

The optimal time for scar revision may differ from scar to scar and patient to patient. Often with time spontaneous softening, fading or flattening may occur yielding acceptable cosmetic results. During this period the patient needs to be encouraged that their scar will improve in time. Makeup can be used as an important adjunct to scar revision and camouflage and decrease levels of anxiety until the corrective revision is performed. Optimal time for performing dermabrasion is approximately 8 weeks. Revision of scars with significant dermal components is usually delayed until 6-9 months after initial surgery to allow for scar maturation.

Future Trends In Acne Treatments

Medical Management

Among developmental products, two pharmaceutical products are being tested for scar therapy. Designed to inhibit hypertrophic scar formation following surgery or trauma, EXC 001, from Excaliard Pharmaceuticals, prevents scarring by interfering with connective tissue growth factors. Capstone Therapeutics (Tempe, Ariz.) is currently working to develop AZX100, a novel synthetic 24-amino acid peptide, one of a new class of compounds in the field of smooth muscle relaxation and fibrosis. The compound is currently being evaluated for prevention of hypertrophic and keloid scarring

Celotres, from Halscion, Inc. (Suwanee, Ga.) is a hydrogel scaffold intended to improve the appearance of incisional scars. It is injected into the subdermal layer prior to final closure of an incisional wound, and also addresses keloids.

Other emerging technologies also hold tremendous promise. For instance, **embrace**™ technology, from Neodyne Biosciences, Inc,is a new approach to dealing with post-surgical scars. It has been clinically proven to reduce scarring by providing a uniform compressive strain across the length of an incision, via a specialized applicator and tension treated elastomeric dressing. The dressing adheres over the closed incision and surrounding skin. When released from the applicator, the dressing retracts, providing a flexible uniform compressive strain that actively controls mechanical stresses across the length of an incision site.

Among the new developments in non-traditional therapies, localized **oxygen infusion** has been shown to treat vascular trophic lesions and scars, especially ones that are difficult to heal.

Procedural Management

An interesting pressure injection system for introducing HA into acne scars over multiple sessions has had good results. The machine is capable of pneumatically accelerating a carrier fluid jet containing high-mass molecules of HA. The accelerated jet penetrates the epidermis through a tiny entry point and spreads laterally in all directions once it reaches the dermis, filling a 10- by 10-mm area. This pressure system is able to deliver HA deeply without the stress of needle injections

Azficel-T (laViv) is an autologous aesthetic cell therapy indicated to improve the appearance of moderate-to-severe nasolabial fold wrinkles in adults. The product is available from Fibrocell Science, Inc, a company focused on developing personalized cell therapies for aesthetic, medical, and scientific applications. According to the company, creating azficel-T involves a patented technology whereby fibroblasts are extracted from behind the patient's ear and sent to the Fibrocell Science laboratory, where they are multiplied for about 3 months and are then frozen until needed. Only physicians who complete a Fibrocell-approved training program will be able to administer it.This is a biological that works over time that provides gradual and natural results.

The fractional 915-nm diode laser and bipolar RF coupled with surface cooling lead to coagulation at a depth of about 1–2 mm in the deep dermis. The device has been used to improve wrinkles and skin texture. It was postulated that the fractional laser preheats the target area such that the subsequent RF energy is drawn towards the heated target deep in the dermis while the superficial part is protected by contact cooling. The use of both devices in combination aims to enhance collagen synthesis in the scar indentation at deeper layers by infrared laser and some degree of surface ablation of the scar edges and collagen remodeling by fractional RF . The enhanced collagen synthesis at deeper layers may improve the appearance of scars by elevating the deeper part of the scars, resulting in a more uniform skin surface and improved texture, pore size, and pigmentation irregularity.

Maintaining the theme of combining wavelengths, YouLaser MT, from Quanta System S.p.A. is a new, innovative device for performing skin rejuvenation and scar reduction in a single session, with almost no downtime. It employs proprietary Mixed Technology, which combines 10,600 nm and 1540 nm wavelengths in a sequential or simultaneous fractional emission, for the effective treatment of scars such as acne scars, delivering a deep dermal stimulation to lift the scar depression, combined with ablation of the edges.

Using both non-ablative Nd:YAG and fractional ablative Er:YAG wavelengths, the TwinLightR treatment from Fotona is part of a comprehensive scar reduction regimen. This type of dual wavelength scar therapy provides a more comprehensive and effective solution due to the synergistic effects that are associated with combined use of the complementary Nd:YAG and Er:YAG wavelengths.

The Fraxel DUAL 1550/1927 from Solta Medical, is a dual-wavelength fractional laser system for both deep and superficial resurfacing indications, as well as treating surgical and acne scars. The system’ s 1550 nm wavelength penetrates deep into the tissue to produce healthy, new skin cells with increased collagen density to

smooth the rough skin typical of scar tissue. Its 1927 nm wavelength treats pigmentation often associated with scars and other dyschromia.

Another fractional, non-ablative device, the 1340 ProDeepR laser, from INDUSTRA Technologies delivers energy to subdermal layers to stimulate deep collagen for continuous improvement of atrophic, post-surgical and acne scars

CO2RE, from Syneron Medical Ltd., is a robust fractional CO2 resurfacing system that enables practitioners to effectively target and treat the skin's surface, middle and deep dermal layers; perform traditional resurfacing or laser excision of lesions. Physicians can minimize the appearance of deep acne scarring by combining CO2RE with RF-based treatments using the eMatrix system (Syneron). eMatrix' s Sublative™ fractionated bipolar RF energy places heat into the upper dermis where it creates an increase in both collagen and elastin.

In 2012 Lumenis GmbH unveiled the SCAAR FX™ (Synergistic Coagulation and Ablation for Advanced Resurfacing) module expansion of its UltraPulseR CO2 laser. The SCAAR FX treatment, which is delivered via the DeepFX handpiece, is intended for the treatment of hypertrophic, surgical and acne scars, including contracted tissue of varying thicknesses.

Synchro VASQ, from DEKA, is an innovative platform that represents a new vascular laser concept. The RightLight™ pulsed dye lamp handpiece uses an optimized, organic fluid to eliminate superficial lesions. In addition, Synchro VASQ has been effective in improving hypertrophic scars and scarring vascular components, thanks to a high-energy laser emission pulse. Regenlite from Chromogenex, Ltd., is another technological advancement in the pulsed dye laser category. Its patented laser cavity produces an exclusive short pulse with fast rise time, delivering 80% of the pulse energy in the first 150 μs. This unique 585 nm pulse shape targets the smallest of microvasculature, using subpurpuric energy to create a bio-stimulatory effect and initiate a wound healing response without creating trauma. Low treatment energies (typically 2.5 – 3.0 J/cm2) negate the need for analgesia or cooling during the procedure, leaving no visual signs of treatment. All skin types can be safely treated without concern for pigment issues. Also, the device can be used to treat acne and traumatic scars.

The implications of combining fractional resurfacing systems, topical bimatoprost, and topical retinoic acid may be an improvement of melanocyte density over the scar area, enhanced melanogenesis and melanosome transfer to keratinocytes, and better melanin distribution. Topical retinoic acid may also increase the effect of topical bimatoprost by enhancing its penetration into the epidermis. The overall effect is improvement of hypopigmented scars.

Non-invasive energy for scar treatment is also rapidly improving. In addition to skin tightening, the Reaction™,from Viora, Ltd. provides scar correction and striae improvement. Delivering pain-free, this multi-frequency, bi-polar RF device features the firm' s CORE™ (Channeling Optimized RF Energy) technology, which uses three individual frequencies allowing various penetration depths and a multi-channel mode that incorporates all frequencies simultaneously

Representative of new, multi-modality RF is the INFINI, from Lutronic Corp. This 2-in-1 fractional RF system features two modalities: Microneedle Fractional RF (MFR) and Superficial Fractional RF (SFR), on a single platform. MFR creates precise and controllable coagulation zones deep within the dermis; the three-dimensional fractional volumization of MFR provides dramatic skin tightening and rejuvenation, and a more comfortable procedure. Adjustable depth microneedles deliver energy deep in the dermis without damaging the surrounding tissue. SFR offers non-invasive delivery of RF energy to the epidermis and dermis using a dual channel delivery system.

The effect of low level laser therapy (LLLT) by LED therapy in the reduction of aberrant scars following scar revision by CO2 or surgery revealed that abnormal wound healing can potentially be modulated with LLLT and that the volume of scar tissue, reduced after surgical scar revision or CO2 laser resurfacing in prone patients. Non thermal infra red (NIR) irradiation may enhance the wound healing process presumably by its biomodulatory effects. It is possible that multiple cell signaling pathways contributed to the observed therapeutic effect. TGF-bI and other families of molecules have been shown to be modulated by LLLT, including transforming growth factor platelet derived growth factor (PDGF), interleukins (IL-6, 13, 15) and matrix metalloproteinases (MMPs) which are all also associated with (abnormal) wound repair . Moreover, it has been shown that CO2 therapy can reduce TGF-bI expression, which might have played a part in the overall effect in patients treated with this modality

Conclusion

Scarring is an unfortunate complication of acne vulgaris in the general population. To adequately manage this occurrence, one should understand the underlying cause so that attempts at prevention can be effectively implemented. However, if pre-emptive intervention is not effective or the patient presents after the lesions are already established, then knowledge of proper treatment options is essential. There are multiple options that can be tailored to each individual's needs, tolerance, and goals along with the physician's assessments, skills, and expectations. Medical, surgical, and procedural options are all historically proven and often modified methods to consider. More contemporary options include fillers and laser or energy-derived therapies that are constantly being introduced and currently being tested. Whatever the choice, it should be clearly understood by both physician and patient that, at present, improvement of scarring, rather than total cure, is the probability. With many newer treatments, we can offer the twin hopes of efficacy and safety. It is always tempting to offer patients what is new as being the best and what we learned recently as the panacea and dismiss what has gone before, but successful practitioners need to take on board the intrinsic difficulty of scar revision and develop as many techniques as possible to treat each type of scar and patient optimally. Of the many aesthetic procedures that combine professional technique and artistry, the treatment of scars may be the most delicate. The field of scar revision and prevention has progressed considerably in recent years. Physicians currently have access to several different scar removal methods depending on the type of scar.