

**TITLE: Office-based Cosmetic Procedures**

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Facial rejuvenation is something that has been sought after as long as beauty has been desirable. Cleopatra is rumored to have applied the material left in the bottom of wine casks to her face. During the middle ages old wine was used to rejuvenate skin. Others used soured milk. Today's facial plastic surgery practice offers many modalities to address facial ageing. Since the early 20<sup>th</sup> century, addressing facial rhytids and unwanted skin changes has usually required an in-patient stay or at least a significant period of healing time. Today's cosmetic patients, with busy schedules and work demands, are increasingly desirous of office-based procedures that require minimal recovery time.

The development of more affordable and less-ablative lasers, alternative light treatments, less destructive chemical peels, microdermabrasion, botox injection, thermal resurfacing, injectable fillers, and liposuction have resulted in a reported 50% of cosmetic procedures being performed in the office. The cosmetic surgeon can significantly augment his practice by offering these in-office services. In many centers, aestheticians are utilized as physician extenders to provide these services or to follow the patients after treatment.

Any cosmetic or skin health intervention is recommended only after a review of the patient's medical history (including abnormal scarring, autoimmune disease, etc.), current skin or facial cosmetic complaints, and current skin care regimen (including recent retinoid use). This is followed by examination of the patient's face (facial analysis) with emphasis on areas of concern to the patient. Detailed facial analysis includes evaluation of general skin health, dyschromias, vascular lesions, rhytids, skin thickness, skin type (Fitzpatrick classification), and scarring. After this evaluation a frank discussion between the patient and the physician ensues. Understanding the patient's wishes in regards to cost and "down time" is important when determining which interventions to recommend. Often, patients will elect to pursue "non-invasive" options. The physician is obligated to explain that these treatments, though helpful, may require multiple treatments and are seldom as effective as more invasive options. Good skin health should be discussed with each patient no matter what they decide.

## Laser treatments

Laser resurfacing requires an understanding of the physics of lasers as well as their interaction with the skin. "LASER" is an acronym for light amplification by stimulated emission of radiation. Laser light is coherent, collimated, and monochromatic. The effects of laser light are secondary to these characteristics as well as fluency, power density, and frequency. Coherence is demonstrated in both time and space and is analogous to a marching band keeping in step. Collimation results in a powerful beam of light that can be focused in a small area with precision. Laser monochromatism means the laser light is made up of one wavelength only (instead of the multiple wavelength found in white light).

Laser energy, as with all light energy, can be reflected, scattered, transmitted, or absorbed. The effects of a laser on biological tissues is a result of its interaction with that particular tissue. In order for a laser to be of any effect, it must be absorbed. In any tissue exposed to laser light, there will be differing amounts of energy damage depending on absorption characteristics.

In addition, each tissue component has a unique relaxation time. This relaxation time is defined as the time necessary to disperse 50% of the incumbent energy to surrounding tissues. Pulsed (Q-switched) laser energy has been touted to result on diminished injury of non-targeted tissues. This effect is based on the idea that if energy is administered for a time equal to or less than the relaxation time of any tissue ablation will result with minimal thermal damage to surrounding tissues. In other words, it ablates the target tissue before it is able to conduct the energy to surrounding tissues without having to deliver continuous energy which might injure non-target tissues. Thus, specific tissues can be targeted based on their relaxation time and absorption profiles. For example, the integument system is made up of several structures and cell types. Each of these will absorb light at different wavelengths and will have different relaxation times. Chromatin and hemoglobin absorb light at different wavelengths than the surrounding cells. They also have different relaxation times. If laser energy is introduced that is preferentially absorbed by one of these substances and pulsed to approximate their thermal relaxation time blood vessels or skin dyschromias are preferentially destroyed. In order to vaporize target tissues fluency must exceed the vaporization threshold of that tissue. In other words, the power delivered must be enough to vaporize the tissue. Many lasers use bursts of four or five stacked pulses in each pulse of light delivered in order to achieve the necessary fluency to preferentially ablate tissues.

The three dominant chromophores in skin are water, melanin, hemoglobin, and collagen. Each of these absorbs light at different wavelengths. Importantly, melanin shows strong absorption over a broad range of wavelengths. The hemoglobin spectrum is very similar to melanin. This means that persons with darker skin (more melanin) may be at risk of hypopigmentation and decreased efficacy of laser treatment for vascular targets. Water absorbs wavelengths in the low ultraviolet and infrared spectrums. This means that wavelengths of 650-1200 nm (near-red and infrared) will penetrate the deepest of any wavelengths. This is why the CO<sub>2</sub> laser with a wavelength of 10,600 nm, penetrates only 20  $\mu$ m (a function of its absorption by water).

Laser energy absorbed by tissue can result in three types of reaction. It may produce

thermal energy, chemical change, or optical breakdown with formation of plasma. Intensity of the light and length of exposure determine the reaction. High intensity with short exposure time leads to a photothermal reaction whereas low intensity light with a long exposure time leads to photochemical changes. Finally, very high intensity applied for extremely short periods of time leads to plasma formation with cavitation and an expanding shock wave. All three reactions can be seen in any one laser application. Photochemical changes are not generally utilized for cosmetic procedures, though some feel increased collagen synthesis after a laser peel may be secondary to this change. Photodynamic therapy is an example of this type of tissue interaction (sensitization of neoplastic tissues followed by light application which results in free radical formation and tissue destruction). Photothermolysis is the reaction exploited for the targeting specific chromophores and has been described above. Finally, very high-energy lasers applied for short periods of time have been used to address tattoos (Q-switched ruby, Nd:YAG, or alexandrite).

Lasers can be used to address a wide spectrum of facial cosmetic problems. Facial rhytids (both deep and fine), cutaneous dyschromias (port-wine stains, telangiectasias, actinic keratoses, etc.), skin irregularity, unwanted facial hair, and tattoos have all been treated with lasers. Laser facial resurfacing is usually performed with the CO<sub>2</sub> laser. This laser produces a long wave-length beam which targets the water in the superficial skin. Lasers offering fluence greater than tissue vaporization threshold ( $5\text{J}/\text{cm}^2$ ) and pulse width less than tissue relaxation time (1msec) are desired. Resurfacing with the CO<sub>2</sub> laser has been shown to have results comparable to chemical and mechanical peels. Healing is comparable or shorter in duration than other methods. Other lasers have been used to perform facial resurfacing including flash scanner-enhanced CO<sub>2</sub> laser, Erbium:YAG, and combination modalities. Erbium:YAG laser resurfacing is felt to cause less thermal damage to surrounding tissues and may be used in the neck and other body surfaces.

Nonablative facial rejuvenation includes the Nd:YAG laser which has been shown to result in increased dermal collagen deposition without destruction of the epidermis. The light is non-specifically absorbed by the water in the dermis. This results in thermal stimulation of dermal fibroblasts at the papillary and mid-reticular dermis. Epidermal cooling is necessary for this application. The 1450 nm diode laser has also been described as moderately effective for treatment of photoaged skin without ablation of the epidermis. IPL has also shown to result in increased upper papillary dermal collagen formation. It is also especially effective in treating dyschromias and mottling. All these applications require multiple treatments for best outcomes.

Thermal resurfacing (coblation/radiofrequency ablation) is essentially removal of the outer layers of skin by bipolar electrical current. Electrons are used to disrupt molecular bonds and remove layers of skin. Povidone iodine is applied to the skin followed by a local anesthetic and saline gel. Saline solution can also be used. The stylet is kept in constant contact with the skin and the current excites ions in the saline application which then interact with molecular bonds and separate the dermal-epidermal junction. Skin is aggressively cooled during this treatment. Antiviral and antibiotic prophylaxis is provided. There is less data about this intervention, but it appears that it is probably less effective against rhytids than CO<sub>2</sub> or Er:YAG laser treatment, though there is less erythema after this treatment.

## Hair removal

Unwanted facial and body hair have been treated with many modalities. These include hormone treatments, pharmacologic agents, physical removal, camouflage, and electrolysis. None of these provide long-term hair removal and many have substantial side-effects. Recently, intense pulsed light (IPL) and laser applications have become increasingly effective at hair removal.

The target is the hair follicle. Hair follicles are known to cycle between three phases of growth. Anagen is the stage of active growth. Catagen is the involutonal stage. Telogen is the resting phase. A final phase is exogen which is the shedding phase. Hair follicles are best targeted with light and laser during the anagen phase as there is a larger degree of melanin production during this stage and melanin is the target chromophore for depilation. The hair follicle extends into the subcutaneous fat (2-7 mm below the skin surface). The follicle has a relaxation time that differs significantly from that of the epidermis. In order to achieve “permanent” hair removal of the entire terminative area of the hair follicle must occur. Partial destruction leads to regrowth of undesired hair (though the hair may be lighter and thinner than before treatment). Because at one time many phases may be currently ongoing, it follows, that treatments should be additive in effect as each treatment catches more of the units in anagen phase. As the target for laser/light treatment is melanin, light hair responds less well than dark hair. There are multiple office-based lasers available for hair removal. They can be divided according to the wavelength of laser: short (ruby-694nm, alexandrite-755nm), intermediate (diode-900nm), and long (Nd:YAG-1064nm). In general, the shorter wavelength lasers are used on persons with lighter skin (Fitzpatrick I-III), thin hair shafts and blond to light brown hair. Intermediate wavelength lasers are used on Fitzpatrick skin types II-IV, intermediate hair shaft, and light brown to dark brown hair. The long wavelength lasers are best for darker skinned patients (Fitzpatrick IV to VI), intermediate to course hair, and medium brown to black hair. Laser depilation has shown (often after repeat applications) a hair growth reduction of 60-75% at 6-9 months after application.

Intense pulsed light (IPL) is a relatively new technology used for depilation. IPL is a noncoherent, multiwavelength light from 500-1200nm. IPL has been used on patients with a range of pigmentation (Fitzpatrick I-IV) with 48% reduction in hair growth after one treatment (6months). With an average of three treatments a 64.6% reduction has been demonstrated at 6 months. Disadvantages include a requirement for more user sophistication in order to set appropriate treatment parameters. Also, use of aggressive fluencies can lead to linear patches of hyperpigmentation which last up to several months. Finally, the rectangle spot size makes this application somewhat difficult to use in concave/convex areas.

Laser and IPL hair removal is most effective when the hair shaft is in the hair follicle. Therefore, patients should be advised to avoid plucking, waxing or electrolysis 1 month before treatment. The skin is shaved just before treatment to avoid burning of the skin secondary to surface hair coagulation. Topical anesthetics can be used, particularly with the longer wavelength treatments (longer wavelengths require more fluency in order to compensate for reduced melanin absorption). The clinical endpoint of treatment is perifollicular erythema. Skin cooling is recommended. Fluences should be reduced 10-20% if confluent erythema, whitening, blistering or puerpera are noted.

Post-treatment edema lasting for 12-36 hours should be expected. Bland emollients and medium-strength topical steroid creams can be applied. Blistering can be seen but is usually superficial and resolves without scarring. Hypo and hyper-pigmentation can be seen in 10-20% of patients undergoing this treatment. Hyperpigmentation lasts 8-12 weeks. Hypopigmentation can last several months or rarely be permanent. Avoidance of sun exposure for 2-3 weeks before and after treatment should be advised as well as daily application of sunscreen to avoid pigmentary problems. Hydroquinone applied 2-3 times a day can shorten the duration of hyperpigmentation. Reactivation of herpes has not been a problem with this treatment and does not require routine antiviral prophylaxis. Although the optimal schedule is not known, most physicians will retreat at 4-8 week intervals or at the first sign of hair regrowth.

Care should be taken when treating skin around the eye. Eyelid skin, and even corneal shields will not fully protect the eye from laser light. IPL does not represent a risk to the eye as the light is non-coherent. The greatest side effects have been noted with the shorter wavelength lasers. Lower fluencies, active cooling, longer pulse durations, and minimal overlap of pulses should help reduce complications.

## **Topical treatments/medical treatments**

Topical and systemic therapies to address skin cosmesis and health often include both the physician and ancillary staff. Facial plastic surgeons often include an aesthetician in their office-based practice. An aesthetician is a cosmetic professional who is educated in regards to skin care products, makeup application, and cosmetic camouflage. After a full facial skin evaluation by the physician the patient is advised to discuss skin health with the aesthetician. Depending on the physician's level of comfort, the aesthetician can then educate the patient in skin care and may even administer light treatments, depilation, light chemical peels, light microdermabrasion, and other skin treatments under the physician's supervision. They can also be instrumental in providing the time-intensive post-operative care for patients who have received deep peels and other more invasive procedures. It is important that physicians provide proper supervision so that issues such as allergic reactions, post-procedure complications, and even skin cancers are not overlooked. Working together, facial plastic surgeons and aestheticians can address both the cosmetic and day-to-day issues of skin health.

Most maintenance skin care regimes include a cleanser, a toner, and sunblock. Tretinoin, exfoliants, bleaching agents, and other topical agents can be included as appropriate for the patient's particular skin needs. Skin care recommendations might be different for normal skin, skin with photoaging, sensitive skin, and skin with acne. Patients are encouraged to treat their skin twice a day. It is important for a physician to be familiar with commonly-prescribed skin care products.

Topical retinoids are the most popular of the topical therapies to reverse the effects of cutaneous photoaging. Multiple compounds exist. Topical retinoids have been shown to down regulate collagenase and up regulate messenger RNA. Other effects include replacement of atrophic epidermis with hyperplasia, elimination of dysplasia and atypia, eradication of microscopic actinic keratoses, uniform dispersion of melanin granules, new collagen formation in the papillary dermis (type I), as well as angiogenesis (this can prove problematic in rosacea). These effects can lead to reversal of many of the effects of photoaging of the skin. Several

double-blinded, placebo-controlled studies have shown global improvement in appearance, reduction of fine and coarse wrinkling, roughness, pigmentation, and sallowness. These effects are dose-dependant and increase with duration of therapy (at least to 12 months).

The most common problem reported with topical retinoids is cutaneous irritation. This dermatitis characterized by flaky, red skin which is unusually sensitive. The symptoms usually surface 2-4 weeks after beginning treatment and usually resolves if treatment is continued. The product is degraded by sun exposure, so nighttime application is advised. Photosensitivity secondary to thinning of the stratum corneum is also seen with use of this drug. Patients taking medications known to result in photosensitivity should be cautioned as tetracycline, phenothiazines, fluoroquinolones, sulfonamides, and other drugs can result in enhanced phototoxicity. Acne and atopic dermatitis may experience flares, but these resolve with continued use. Recent changes in formulation have been shown to decrease irritation (Retin-A microgel vs. tretinoin 0.1% cream). Adapalene gel is reported to have lower irritation potential, no phototoxicity, and fewer problems with sensitization. Tazarotene gel selectively binds RAR- $\beta$  and RAR- $\gamma$  receptors. Because 90% of the retinoid receptors in the skin are of the RAR- $\gamma$  subtype it could prove more effective. No data on the formulation's effects on cutaneous photoaging is available, however.

Patients should apply the drug in the evening to a clean, dry face. Initially patients should apply the drug 2-3 times a week with moisturizers used as necessary. The drug is eventually used on a daily basis.

Systemic retinoids, usually used to treat acne and psoriasis, have also been touted to reverse the effects of cutaneous photoaging. In one study, patients on systemic retinoids were noted to have improvement in wrinkles, color of skin, thickness of skin, and size of pores after six months when compared to controls. All forms of retinoids are pregnancy class X. Patients should be counseled before use. Some physicians require pre-treatment pregnancy tests and oral contraceptive use during the treatment period.

Vitamin A, or retinol, is a retinoic acid precursor. Other precursors include retinaldehyde and retinyl palmitate. When compared to retinoic acid both vitamin A and retinaldehyde were less irritating, and vitamin A resulted in less scaling. The incidence of erythema, burning and pruritis were also significantly less with vitamin A treatment. Vitamin A has been shown to have increased skin penetration with dermal effects similar to retinoic acid.

Furfuryladenine (Kinerase) is a synthetic cytokinin plant growth hormone which shows some promise when used for at least 24 weeks. The incidence of cutaneous irritation is reported in less than 1% of persons using the product.

Vitamin C is known to be beneficial in protecting cells against UVB damage. Ascorbic acid acts as an antioxidant by neutralizing free oxygen radicals created by UV radiation. One study showed significant improvement in wrinkles, roughness, color and overall features after three months of treatment with a topical zinc, L-ascorbic acid, and tyrosine mixture. Though helpful to prevent UV damage, the place for topical and systemic vitamin C in treatment of photoaging is still unclear.

Vitamin E is a lipid-soluble antioxidant. It also inhibits expression of enzymes that degrade collagen. Animal studies seem to show a photoprotective effect of pretreatment with vitamin E. In vivo human studies have failed to show a significant effect. No data is currently available on long-term vitamin E supplementation and its effect on photoaging.

Hydroxy acids (exfoliants) have long been used for skin rejuvenation. There are several forms that are active exfoliants. Alphahydroxy (AHA) acids are found in many commercially-available products. These acids are water soluble (therefore less penetrating). Salicylic acid is a betahydroxy acid (BHA) and is lipophilic making it useful for oily areas of the face (central forehead, nose, and chin). Polyhydroxy acids (PHA) are similar to AHAs, but are larger molecules with less dermal penetration and therefore less stinging and burning. The exact mechanism of hydroxy acid action is unknown. Clinically, use of these agents results in thickening of the epidermis, decrease in the stratum corneum, and an increase in deposition of glycoaminoglycans. Hydroxy acids should be used once or twice a day.

Bleaching agents are used to treat dyschromias of the skin. Hydroquinone is the most frequently prescribed agent in the United States. It produces reversible depigmentation by inhibiting the enzyme tyrosinase which results in decreased melanin production. A 4% solution may be applied twice a day. Optimal results are obtained when used with sunscreen, an exfoliant, and a retinoid. The drug may cause redness, irritation, and dryness. Infrequently, patients may have allergic reactions to product additives. Rarely, permanent dark blue-black pigmentation can result from hydroquinone use (exogenous ochronosis). Kojic acid is the only other commonly-used bleaching agent. The chemical is extracted from a Japanese mushroom. The effects of kojic acid are similar to hydroquinone, though more irritation has been reported.

Copper is a mineral which is important for production of collagen and acts as an antioxidant. Copper-peptides have been shown in animal models and human cell cultures to result in angiogenesis and formation of glycosaminoglycans, collagen, and elastin. No clinical data supports its use.

Moisturizers and emollients are frequently used to treat aging skin. Emollients are substances that smooth the skin surface and may or may not have moisturizing properties. Moisturizers can be occlusive or humectants. Occlusive moisturizers prevent transepidermal fluid loss and is usually petroleum or oil-based. Humectants absorb moisture into the stratum corneum and are usually based on glycerin, propylene glycol, or sorbitol. Silicone is unique in that it is an emollient without the greasiness of the petroleum or oil-based products.

Sun protection is very important for skin health. It is never too late to begin protection against ultraviolet light damage. Patients should be made aware of the importance of protection against the sun, and encouraged to incorporate UVA/UVB protection into their daily skin care regimen. Wearing hats and sunglasses is tolerated by most patients. The use of proper sunblock is important, especially for more active patients. UVB sunscreens are effective in absorbing the entire UVB spectrum. UVA sunscreens are less effective, only absorbing the shorter wavelengths (320-360 nm). UVA sunblock is recommended. 2% and 6% microfine zinc oxide and titanium dioxide provide good protection against both UVA and UVB radiation, though zinc oxide preparations appear to be more effective. Both of these formulations leave a white sheen over the skin. These products are not allergenic. In addition to recommending UV radiation

protection, patients should be cautioned against tanning salons, the role of concrete, snow, water and sand on reflection of sunlight as well as how glass and clouds do not fully block UVA.

## Chemical peels

Chemical peeling consists of applying a chemical to the skin that results in cutaneous injury to a specific level. The growth of new skin with improved surface characteristics results from the injury. Peeling chemicals are classified by the depth of the injury they cause: superficial, medium and deep. Superficial peels result in epidermal loss, whereas medium-depth peels create injury to the level of the superficial dermis. Deep peels cause mid-dermal injury.

The preoperative workup includes evaluation of the patient's skin type, degree of skin aging, and elucidation of pertinent medical problems. Fitzpatrick's classification is important as patients with type I and II have a low risk of pigmentation problems after a peel (hypo or hyperpigmentation). Patients with types III-VI skin are at increased risk for these complications. A patient's degree of skin aging is helpful in deciding what level of cutaneous injury should be pursued for best outcome. Patients with mild aging are best managed with a superficial peel and topical treatments. Those with moderate to advanced aging (wrinkling, discolorations, acne scarring) benefit from medium-depth peels and long-term medical therapy (retinoids vs. alpha-hydroxy acids). Finally, those with severe aging changes are best addressed with a medium or deep peel, though surgical intervention is often necessary to achieve optimal results. Patients with a history of abnormal scar formation, radiation therapy, Accutane therapy in the last 6 months, previous resurfacing procedures or facial surgery should be noted. Patients who have had radiation therapy should be evaluated closely. The general rule is that the presence of facial hair indicates intact pilosebaceous units which should be able to result in adequate healing. Patients with rosacea, seborrheic dermatitis, atopic dermatitis, and psoriasis are at increased risk of post-op complications (prolonged erythema, disease exacerbation, contact hypersensitivity, and delayed healing). A history of previous herpes simplex infection is also important to know. The patient's medical history is increasingly important as the depth of peel increases. Deeper peels result in more injury to the skin and therefore increase the risk of poor outcomes in the face of poor/abnormal healing, or cutaneous diseases.

Patients should understand the limitations of facial peeling. Facial peels can improve the appearance of sun-damaged skin, flatten mild scarring, smooth out rhytids, destroy epidermal lesions such as actinic keratoses or lentiginines, ameliorate underlying skin problems such as acne, remove pigmented lesions, and blend the effects of other interventions (face lift, etc.). A peel cannot reduce pore size, eliminate telangiectasias, eliminate deep scars, or efface deep wrinkles.

Before a medium or deep peel is undertaken, patients should be prophylactically treated with an antiviral agent. The antiviral drugs are fully effective only in intact epidermal cells. Therefore, the drug is continued for 2 weeks in deep peels and 10 days in medium peels. Superficial peels do not require prophylaxis. Most patients are started on a weak tretinoin solution 1-2 weeks before the peel. This results in acceleration of epidermal healing, increase of the depth of injury (thinning of the stratum corneum). Postoperatively, tretinoin should be discontinued until reepithelialization has occurred. Patients with type III or higher skin types often benefit from 4-8% hydroquinone gels applied twice a day pre and post-operatively. This

drug is also helpful when peeling patients of any skin type who have problems with cutaneous dyschromias.

Superficial peels can be further divided into very light and light peels. Very light peels injure only the stratum corneum. 10-20% TCA, Jessner's solution, tretinoin, salicylic acid (a beta-hydroxy acid) are all used for very light peels. Light peels injure the entire epidermis. Light peels are performed using 70% glycolic acid (an alpha-hydroxy acid), 25-35% TCA, and solid carbon dioxide slush. Glycolic acid is different from the other peeling agents as it must be rinsed off with water or neutralized with sodium bicarbonate after 2-4 minutes after application. TCA peels are accompanied with mild stinging. The light and very light peels are easily applied and have few side effects. These peels require minimal down-time with many patients returning to work immediately after the application. Superficial peels can be performed on a weekly basis.

Medium-depth peels offer results that even repeated superficial peels cannot match. In the past concentrations of TCA approaching 50% or higher were used to achieve injury to the superficial dermis. Because of a high risk of scarring and pigmentary complications, 50% TCA peels have been modified to include 35% TCA in combination with pre-application of Jessner's solution, 70% glycolic acid, or solid CO<sub>2</sub>. A Jessner's-TCA peel is applied by first thoroughly cleansing the skin. This is done by washing the face with Septisol and degreasing the skin with acetone. Fully degreasing the face is essential to avoid a splotchy peel which can result from uneven penetration. Jessner's solution is applied with a painless white fine frosting resulting. Once the Jessner's solution has dried, 35% TCA is applied to the facial subunits. A white frost should result within 30 seconds-2 minutes. Reapplication for areas of uneven frosting should be delayed at least 3-4 minutes to allow for frosting to reach its peak. The desired outcome is a white-coated frosting with a background of erythema. A solid white enamel frosting without an erythematous background indicates injury to the reticular dermis and is too deep for a medium peel. It is especially important to avoid over-aggressive peeling over bony prominences (jawbones, cheekbones, and chin) as these areas have an increased tendency to scar. Some keratoses may require vigorous scrubbing in order to achieve sufficient penetration. Peel solution should be feathered onto unpeeled areas (hairline, brows, neck, and vermillion border). For deep rhytids peel solutions may require application with the wood portion of a cotton applicator. This is especially helpful in perioral rhytids. Eyelid skin should be treated with a semi-dry applicator and carried down only to the level of the superior aspect of the tarsus on the upper lid and to 2-3 mm from the lash line on the lower lid. Tears should be immediately dried with a cotton applicator as they can pull peel solution into the eye by capillary action, or roll onto the neck resulting in a linear streak. Post-operatively, the patient should soak the face several times a day with warm compresses (mild acetic acid solution is sometimes recommended) and apply an emollient after each soak. Initially, there is an edema and erythema with sloughing of the skin. Crusting usually occurs which peels off around 4-5 days after treatment. The underlying new skin is initially pink or erythematous. This can be camouflaged with makeup and usually fades over a period of several weeks. Retinoids and sunscreens are restarted after reepithelialization has occurred. Another medium-depth peel is not recommended for 3-9 months. The final results of a medium-depth peel may not be realized for 3 to 4 months.

Deep peels are usually performed using the Baker-Gordon solution. This preparation includes phenol, water, Septisol, and croton oil. Septisol acts as a surfactant which results in more even penetration. Croton oil is a vesicant epidermolytic agent that enhances the absorption

of phenol (phenol applied alone results in only a medium-depth injury). Phenol, the active agent, is known to have cardiac toxicity and has hepatic and renal elimination. These effects necessitate a more in-depth workup and usually include a monitored setting for the application. An anesthetist or anesthesiologist is required to administer sedation and analgesia while monitoring the patient's cardiac status, pulse-oximetry, and blood pressure. Pre and intraoperative hydration is provided. Facial subunits are addressed one at a time with 15-minute time interval between units. This is done to avoid buildup of phenol to toxic levels in the blood. These peels are rarely done in the office, though some physicians have developed minor operating rooms within their offices which are equipped for this intervention. Application and post-operative care are similar to that of medium-depth peels. Some surgeons occlude the peel with water-proof tape in order to increase the depth of injury. Oil is used to dilute the peel solution in the event that it should enter the patient's eyes as water only increases the depth of phenol penetration. Erythema may take months to resolve. Pigmentary changes and scarring are also more frequently seen with deep peels. The skin continues to improve over several months as collagen remodeling takes place. A remarkable degree of improvement is to be expected.

## **Dermabrasion**

Dermabrasion is a time-honored method of skin resurfacing. It traditionally involved use of an abrasive brushes and friezes to mechanically remove the superficial layers of the skin. Results have been shown to be similar to laser and chemical peels. The safety of the procedure is surgeon-dependant. Dermabrasion is generally thought to require a good amount of experience to be able to perform well. Scarring is a result of excessive depth of dermabrasion. The procedure is still felt to be the best application to address deep scarring, deep rhytids, and acne-related pits and scars. Dermabrasion can be performed in the office with an assistant, though it often requires sedation and even general anesthesia if a full-face dermabrasion is planned. By nature of the procedure, there is a large amount of bloody body fluids that are thrown into the air. Protection for the surgeon and assistants is paramount. Some areas (eyelids) should be hand-debrided. Dermabrasion should be carried across the vermilion border (though at a more shallow depth) when treated periorbital rhytids. Care should be taken to make sure the rotation of the frieze or brush is toward the vital structure (lip, eyelid, eyebrows, and nostrils). Some authors reports good results using a hand-held sanding device. The decreased amount of blood splatter is, of course, beneficial.

Dermabrasion, in expert hands, is as effective as laser resurfacing and deep peeling. The incidence hyperpigmentation is not different from either of the other interventions, though erythema is much decreased with dermabrasion. Hypopigmentation has been reported to be increased with dermabrasion when compared with laser treatment, especially in those patients on birth control pills and in those patients with heavily pigmented skin.

Microdermabrasion is a more recent development which is less operator-dependant, more consistent in depth of tissue loss, and results in little blood exposure. The device is a closed system which pumps aluminum oxide crystals at high speeds at the skin surface. Suction is applied to remove the crystals and skin debris. Increasing the pressure, the amount of crystals used, and changing the speed with which the device is moved across the skin will influence the depth of the debridement. One hand holds the hand piece while the other stretches the skin being treated. Direction of passes should vary and pressures should be decreased around facial

orifices. Usually two passes are needed to completely remove the epidermis. Pinpoint bleeding indicates sufficient depth. Delicate skin should not be treated. Care should be taken to avoid getting crystals in the patient's eyes. After treatment crystals remaining on the skin are brushed off and a moisturizer is applied.

Microdermabrasion results are not usually as dramatic as traditional dermabrasion. Several treatments may be needed. Some concern over the use of aluminum crystals for dermabrasion has been expressed. If the depth of dermabrasion is unusually deep the particles can be retained in the skin with a foreign body reaction resulting. This has not been noted to be a problem in the clinical setting. Nevertheless, microdermabrasion is usually stopped once there is evidence that the epidermis has been removed. Sodium chloride crystals have been used, though they are not as effective as aluminum oxide crystals. This is likely because aluminum is much harder a material. Healing time is much less than more aggressive treatments (peels, dermabrasion, laser treatments), erythema usually resolves after 24 hours, and the risk of hypo/hyperpigmentation and scarring is minimal. Microdermabrasion can be performed by a trained aesthetician under a physician's supervision. No anesthesia is needed.

Microdermabrasion is recommended for patients who have minor degrees of sun damage, wrinkling, or acne scarring. Patients who have had more aggressive procedures can benefit from microdermabrasion to blend treatment boundaries and as a maintenance therapy. Patients with clogged pores may realize an increased benefit with this procedure over others. Patients with darker skin tones may find this option less risky. Finally, patients unwilling to undergo more aggressive procedures or who do not have the "down time" to pursue those options are good candidates for this microdermabrasion. Patients with active acne, a history of retinoid (Accutane) use in the past year, and a history of keloid formation are offered alternative treatments. Anecdotally, patient satisfaction seems high, though little objective data on outcome exists.

## **Injectable materials for soft tissue augmentation**

Injection of material for soft tissue augmentation dates to 1899 when Gersuny injected paraffin as a cosmetic intervention. Since then there has been a continued effort to find injectable materials that are well-tolerated on injection, have minimal foreign-body reaction, minimal resorption, and effective at soft tissue augmentation. Although current options are much better than previous materials, they still fall short of the ideal injectable filler. Despite the imperfect options, fillers are commonly used to efface rhytids and scars, as well as to plump the lips and provide fullness where age, trauma, or infection has left their marks. It is common for patients to report temporary erythema, edema, ecchymosis and induration for the first 72 hours after injection. Luckily, these complaints are felt to be the manifestation of sensitivity, not allergy. True complications such as wound infections, herpetic reactivation and local skin necrosis are thankfully rare.

Injections are typically done using a 30-gauge needle (some fillers require larger-bore needles). Anesthetic can be applied topically or mixed with the filler. The plane of injection depends on the depth of the scar or rhytid to be effaced. Most rhytids can be effaced by injection into the mid-reticular dermis (the skin blanches after injection). Deeper wrinkles (nasolabial fold) and deep scars may require lysis of underlying adhesions and subdermal or deep dermal

injection. Cutaneous defects which flatten with tension do not usually have deep adhesions and will respond better to injected materials.

There are generally two methods of injection. In the serial injection technique multiple injections are made with the needle at a 30 degree angle to the skin along the rhytid or defect. Alternatively, the injection can be made by threading the needle through the dermis along the line of the defect and then injecting slowly as the needle is withdrawn. It is important to stop injecting before removing the needle so that the injectate remains in the dermis and is not deposited more superficially (this leads to palpable nodules). Lips are generally injected using the latter method and the injection is placed at the vermillion border.

Available xenografts include bovine collagen in several forms (Zyderm I, Zyderm II, Zyplast). Bovine collagen was approved for injection during the 1980's and for some time was the only injectable agent routinely used in the United States. As a result there has been a large amount of research into this material. As a result, many view bovine collagen as the gold standard against which all other options must be compared. Commercially available preparations consist of purified, enzyme-digested bovine collagen (95% type I, <5% type III collagen). The preparation is reconstituted with phosphate-buffered saline with 0.3% lidocaine. Materials available since 1985 undergo glutaraldehyde processing to crosslink lysine residues with the theoretical decrease in absorption. Zyderm I and II are expected to retain only 30-60% of their bulk and therefore should be overinjected. Zyplast, on the other hand, retains nearly 100% of its volume and should not be overinjected. All of these products are resorbed at 3-4 months and thus require repeated injections to maintain the desired effect. Zyplast is usually injected in the deep dermis to address deeper rhytids and scars with Zyderm I and II used to layer over the deeper injection or to address more superficial defects.

One significant drawback has resulted in the continued search for additional fillers. The potential for hypersensitivity reactions to a xenograft has prompted the manufacture to recommend intradermal skin testing before use on the face. This requires up to 6 weeks before initiating treatment. A small amount is injected into the dermis. Hypersensitivity is seen in 3% of patients undergoing this test. 70% are positive in the first 72 hours. Another 1-2% will only show hypersensitivity on a second injection. For this reason some physicians will inspect the injection site at 2 to 3 days after injection and four weeks after injection. Others require two test injections before they will proceed. Despite these significant drawbacks to its use, this product has a 20-year track record of producing consistent, good results which unfortunately fade after 3-4 months.

Hyaluronic acid derivatives are currently derived from either cocks combs (Hylaform fineline, Hylaform, Hylaform Plus) or microbial culture (Restylane Fine Lines, Restylane, Perlane). Resylane was only recently approved for use in the United States. Both products have been used in Europe and elsewhere for many years with good effect. Hyaluronic acid is a naturally-occurring molecule composed of chains of repeating disaccharide units. These molecules are hydrophilic and provide turgor to the extracellular matrix of connective tissues. In the 1980's the product with modified with cross-linking induced to avoid early resorption. An important characteristic of hyaluronic acid is the fact that it is identical across species. This means that, if properly purified, there should be little or no immunologic reaction to the substance. This also obviates the need for a skin test. Patients with allergies to avian products

should avoid use of Hylaform products. Restylane is metabolized by the liver into carbon dioxide and water. It does not require refrigeration and can be stored at room temperature for up to a year. Any product that is noted to have separated in the syringe should not be injected, no matter its date of expiration.

The Hylaform and Restylane fine line products (particle size of 300/150  $\mu\text{m}$ ) are used for superficial rhytids as well as to layer the larger particle deeper injections. This product should be injected into the superficial dermis. Hylaform and Restylane (particle size of 500/250  $\mu\text{m}$ ) are injection into the mid-dermal layer to treat perioral lines, shallow facial folds, and scars. Hylaform Plus and Perlane (particle size of 700/1000  $\mu\text{m}$ ) are reserved for deeper rhytids like the nasolabial folds, oral commissures, and lip enhancement and are injected into the deep dermis. No overcorrection is necessary. Effects have been shown to last about 9 months with a high patient satisfaction rating.

Risk of a hypersensitivity reaction (as described above) is very small--0.6% noted since 2000. Of these patients, 50% are immediate reactions which resolve within three weeks. 4 sterile abscesses have been reported. Unwanted results after injection with these materials usually resolve within a year as the filler is resorbed. At least one patient had prolonged residual injection material which was treated successfully with hyaluronidase. Studies have shown outcome equivalence with bovine collagen and synergetic results when used with botox injections. Recent studies show benefit when autologous fibroblasts are injected with the hyaluronic acid.

Autologous materials include autologous fat, Isologen, and Autologen. Isologen and Autologen are cultured fibroblasts and extracted autologous dermal matrix, respectively. These products require skin harvest from the patient with injection delayed 4-6 weeks for cell growth to occur. The product is sent via overnight mail and must be injected the next day. Multiple injections are required for good effect. Despite the inconveniences this sort of approach might represent, preliminary data seems to show good results at up to 5 years after injection. These studies report up to 75-100% persisting volume at five years and little or no inflammatory reaction after injection. Autologen requires a significant amount of skin to be harvested (2 inches square is needed for 1 ml of injectable product). Thus, this approach is likely only possible after some skin-sacrificing surgery. Tissue can be stored for up to 6 months. It appears that multiple injections are necessary with this product, as well. Long-term results are unknown. One study showed Autologen to be at least equal to bovine collagen in volume at 12 weeks. The use of adipose tissue for soft tissue augmentation was first reported in 1893 (Neuber). Today's common use of liposuction provides a large amount of adipose tissue that can be used for this purpose. Unfortunately, the volume of tissue that can be expected to remain viable at the injection site is highly variable. Authors report anywhere from 30-60% resorption over time. This degree of uncertainty is likely the reason that autologous fat grafting is not used more often. None of the autologous injectable materials require skin testing.

Homografts (Dermalogen, Cymetra, Cosmoderm, Cosmoplast ) are products prepared from cadaveric dermal tissues. They are acellular preparations and therefore should have little cross-reactivity. Skin testing is not required. Overcorrection of 20-30% is required. Few studies exist to evaluate long-term effects of homograft injection. At least one author reported persisting volume of Cymetra to be twice that of Zyplast at one month after injection. Histology showed

fibroblast ingrowth whereas Zyplast did not. The same author reported better long-term lip augmentation when compared with Zyplast, though multiple injections were required.

Synthetic materials (silicone, Artecoll) provide a more permanent answer to facial rhytids, but with an increased risk of complications. Silicone oil microinjection began in the 1950's. Physicians noted that very small drops injected into the subdermis resulted in fibrous encapsulation and a resolution of the facial rhytids permanently with a very natural feel to the skin. Unfortunately, local and systemic results were identified that made the use of this substance less attractive. Removal is technically very difficult, if not impossible. The FDA outlawed its use in 1991. Artecoll is a combination of poly-methylmethacrylate (PMMA) beads suspended in a solution of 3.5% bovine collagen and 0.3% lidocaine. The microspheres are theoretically too large for phagocytosis and their smooth surface is supposed to resist migration. Artecoll is used to address deeper wrinkles, nasolabial folds, and lip augmentation. It is injected into the subdermis as dermal injection can result in nodules and painful swelling which is permanent. Skin testing is required. In one study 90% of 118 patients were "satisfied" with their results. Two patients developed hypertrophic scarring and had to have the implant removed. One allergic reaction was also observed. Other investigators have shown giant cell reaction and extrusion in animal models. The material has been used in Europe for ten years, but still lack FDA approval.

## **Other**

Botox injection is an important adjunct for facial rhytids caused by hyperactive facial musculature. Detailed evaluation of this modality will not be pursued in this discussion. Certainly, botox injection is an important part of office-based cosmetic medicine and can be used in conjunction with other interventions to maximize aesthetic outcome.

Liposuction is also an important part of a cosmetic surgeon's armamentarium. In the head and neck liposuction is most commonly utilized to address adipose deposition in the anterior cervical region. Many authors have proposed different methods of addressing this fat deposition. Some use small-incision liposuction only with post-operative bandaging for several weeks. Others feel a larger incision (2-3cm) allows for direct-vision lipectomy and plastysmaplasty. These patients are also bandaged for a week postoperatively and at night for several weeks. At least one author recommends leaving 7-8 mm of subcutaneous fat on deep surface of the neck skin to avoid unsightly irregularities after healing has occurred.

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