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Epidemiology of Cosmetic Procedures: An Update for Dermatologists

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Abstract The relatively nascent field of cosmetic dermatology has seen a rapid rise in the number of products and procedures used to restore and enhance appearance. Millions of Americans undergo nonsurgical cosmetic procedures every year in the United States. The constant evolution of cosmetic dermatology introduces issues of safety and efficacy, as many of the innovative products and procedures have yet to endure the test of time. Practitioners who perform cosmetic procedures will benefit from recognizing the evidence to support the safety and efficacy of current trends in cosmetic dermatology. This article updates dermatologists on the epidemiology of cosmetic procedures in the United States, reviews recent research studying the motivations of the growing numbers of cosmetic patients, and briefly reviews the safety and efficacy of some of the most popular new nonsurgical cosmetic procedures.

Keywords Cosmetic · Soft tissue filler · Soft tissue augmentation · Botulinum · Laser · Sclerotherapy · Aging · Scar · Safety · Procedure

Introduction

The demand for cosmetic procedures has burgeoned in the United States during the past decade (Fig. 1). In 2010, Americans spent nearly $10.7 billion on a total of 9.3 million elective surgical and nonsurgical procedures, an almost fivefold increase from 1997 [1]. Although thousands of patients sought surgical cosmetic procedures, such as breast augmentation (n=318,123), liposuction (n=289,016), blepharoplasty (n=152,123), abdominoplasty (n=144,929), and breast reduction (n=138,152), millions more underwent nonsurgical cosmetic enhancement [1]. According to the American Society for Aesthetic Plastic Surgeons, the top five nonsurgical cosmetic procedures in 2010 were injection of Botulinum toxin type A (BoNT) (n=2,437,165), hyaluronic acid injection (n=1,315,121), laser hair removal (n=936,270), laser skin resurfacing (n=562,706), and chemical peels (n=493,896). These statistics likely underestimate the true number of elective cosmetic procedures, since the ASAPS statistics do not account for cosmetic procedures performed by specialists outside of dermatology, otolaryngology, and plastic surgery or for procedures performed by nonphysician clinicians (physician assistants, nurse practitioners, etc.) [2].

Americans from various demographic groups seek elective cosmetic procedures. Women account for 92% (n=8.6 million) of all cosmetic procedures performed in the United States, and although men undergo a comparatively lower number of procedures, there has been an 88% increase in volume of cosmetic procedures for males since 1997. Among all ethnicities, whites seek an overwhelming majority (81%) of all cosmetic services. According to the 2010 Census, whites are 72.4% of the American population, and are therefore overrepresented in the population of those seeking cosmetic rejuvenation [3]. People from a wide range of ages seek cosmetic procedures. Growing numbers of young people seek to correct or prevent early signs of aging [4]. In fact, 44% (over 4 million) of the total number of patients that received elective cosmetic procedures were between the ages of 35 and 50. Age groups from 19 to 34 years and 51 to 60 years accounted for 20% and 28% of cosmetic procedures, respectively [1].

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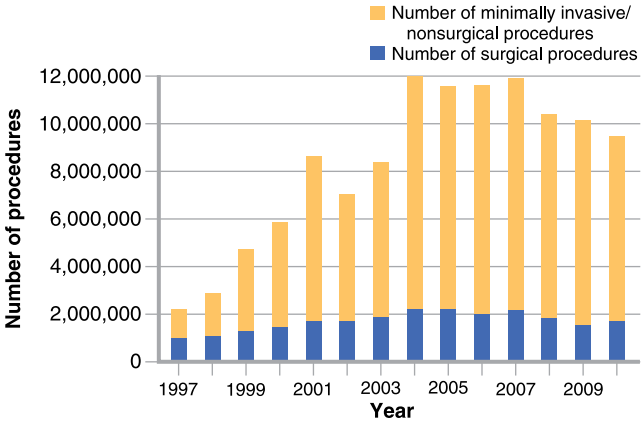

Fig. 1 Total number of cosmetic procedures in the United States by year

Dermatology figures prominently among the specialties delivering cosmetic procedures. When treatment of skin cancers is taken into account, data from the Center for Medicare and Medicaid Services illustrate that dermatologists perform more surgical, laser, and cosmetic procedures than any other specialty [5]. In response to the growing demand for cosmetic procedures, many dermatology programs have incorporated cosmetic topics into their resident curricula. Based on a survey taken in 2009, residents report greater exposure to cadavers and live demonstrations of cosmetic procedures [6]. Dermatology residents are also performing chemical denervation and injecting soft tissue fillers at a level that exceeds "significant exposure" required by the Accreditation Council for Graduate Medical Education (ACGME) and Residency Review Committee (RRC). However, dermatology resident exposure to tumescent liposuction, ambulatory phlebectomy, rhytidectomy, and blepharoplasty remains limited. The American Society for Dermatologic Surgery (ASDS) has over 5000 active members, another indication that cosmetic dermatology is firmly established within the specialty.

The field of cosmetic dermatology continues to evolve rapidly. This article updates dermatologists on trends within cosmetic dermatology, including current research investigating the motivations of patients seeking cosmetic procedures, the latest data on patient safety, and briefly reviews new procedures and technologies.

Factors Influencing Pursuit of Cosmetic Procedures

A number of factors contribute to the increased popularity of cosmetic procedures. First, some may feel pressure to maintain a youthful appearance in the work environment. Workplace prejudice based on physical appearance and attractiveness is a known entity, and one study found that employers believe that attractive workers contribute to the success of their companies [7]. Beauty also impacts one's levels of compensation. Biddle and Hammermesh [8] demonstrated that there is a direct correlation between salary and attractiveness. In their model, "plain people" earned less than "average-looking people", who earned less than those considered "good-looking". When multiple empirical analyses were combined, it was clearly demonstrated that wages of people with below-average looks were lower than those of average-looking workers, the 5–10% "plainness penalty". Second, the growing importance of physical appearance in contemporary Western culture has served to normalize the pursuit of appearance-enhancing behaviors [9]. Other important factors that have facilitated this cosmetic surgery explosion include higher disposable income (particularly of the Baby Boomers), advances in surgical procedures, and lower cost of treatments [10, 11]. Media coverage of cosmetic surgery and reality television programs focusing on cosmetic surgery also raise public awareness and encourage cultural acceptance of such procedures [12, 13].

Psychosocial factors, such as body image, teasing history, and self-esteem, may also motivate patients to seek cosmetic surgery [14, 15]. Whether these cosmetic interventions significantly improve mental health outcomes such as body image and self-esteem has been debated [16–18]. Suboptimal methodology of current studies limits our ability to evaluate the impact of cosmetic procedures on psychosocial status of patients [19].

Although each patient's motivation for desiring enhancement of their appearance may be different, practitioners must be aware of patients with body dysmorphic disorder (BDD), a pathologic preoccupation with a nonexistent or minimal flaw in appearance. Nonpsychiatric treatments are generally not considered beneficial for these patients. A delay in diagnosis can lead to a delay in definitive treatment, numerous unnecessary and potentially harmful procedures, and legal proceedings against dermatologists [20]. Over the past decade, a number of studies have investigated the rate of BDD among patients who present for cosmetic surgery. Methodologically rigorous national and international studies report rates of 3.2–16.6% in cosmetic surgery samples [2]. In a study of 300 dermatology patients in Brazil, the prevalence of BDD was more than twice as high in cosmetic dermatology patients (14%) when compared to general dermatology patients (6.7%) [20]. Conrado et al. [20] argue that broader access to less invasive procedures may have a positive correlation with BDD symptoms and behaviors. Undoubtedly, the cosmetic dermatologist is primed to encounter patients with this psychiatric issue, and identifying BDD in patients will allow for referral to appropriate mental health

professionals rather than performing procedures that may be harmful or unnecessary.

Safety

As the armamentarium of products and devices that enhance appearance continues to grow, dermatologists who perform cosmetic procedures must take precautions to protect patient safety. Between 44,000 and 98,000 Americans die each year as a result of medical errors [21]. Fortunately, there is a wealth of literature to demonstrate that office procedures performed under local anesthesia are very safe, and the complication rate for dermatologists that perform these procedures is as low as <0.5% [22•]. In a 7-year period, more than half of the 31 deaths that occurred during office-based surgery in Florida were due to cosmetic procedures performed by plastic surgeons under general anesthesia, the majority of which were liposuction (67%) [23]. These same data support the notion that liposuction performed with tumescent anesthesia alone is associated with a very low incidence of adverse events.

Wrong site surgery is the most common reason for malpractice cases against Mohs surgeons [24]. Although wrong site surgery is less likely with cosmetic procedures, adherence to the Joint Commission Universal Protocol optimizes patient safety. This protocol entails 1) preoperative verification of relevant documents, 2) marking the surgical site(s) in the preoperative area with patient confirmation, and 3) performing a "time out" with team members before beginning the procedure [25]. Strict implementation of this protocol in a high-volume dermatologic surgery practice has eliminated sentinel events such as wrong site surgery or wrong procedure [26•].

The wide spectrum of interventions in cosmetic dermatology introduces patients to many products and devices that may or may not be approved by the US Food and Drug Administration (FDA). As part of its safety surveillance efforts, the FDA relies primarily on 1) reports submitted to the Agency by health professionals or patients who suspect drugs and medical devices to be associated with serious problems, 2) case reports published in the medical literature, and 3) results of post-approval and other clinical studies when they are performed (FDA 2011). There have been no cosmetic drug or device recalls in the past 3 years [27]. Additionally, a provision to the federal Food, Drug, and Cosmetic Act, the Modernization Act of 1997, allows any legally marketed, FDA-approved device to be prescribed or administered for any condition within a doctor-patient relationship [28]. This act has paved the way for dermatologists to use cosmetic products in an "off-label" manner, such as the off-label injection of BoNT into muscles of the lower face. Although many off-label procedures are safe and effective, patients must be aware of the off-label use before treatment.

The rapid growth of advertisements and marketing of cosmetic procedures raises potential ethical concerns and patient safety issues. An increasing number of cosmetic physicians market their practices through websites and social media networks [29]. Although social media and the Interne can provide useful education to patients about the risks and benefits of particular procedures, some websites may present patients with misleading information that creates unrealistic expectations about outcomes and the cost of cosmetic products and procedures. This debate regarding the ethics of marketing cosmetic services has been discussed in detail elsewhere [30•]. Regardless of one's marketing strategy, it is essential to recognize that as print and website advertising become more commonplace to promote one's practice, patient advertisements must not be biased or misrepresent the risks associated with particular drugs, devices, or procedures [31].

Cosmetic Procedures

Although numerous innovative cosmetic products and procedures have emerged recently, it is beyond the scope of this article to review them in detail. Many of these new products and procedures lack rigorous scientific testing to prove efficacy, and readers are encouraged to study these innovative products and procedures before offering them to patients. Table 1 summarizes these emerging treatments. BoNT, soft tissue fillers (STFs), laser therapy, and sclerotherapy have become the cornerstones of cosmetic dermatology, and their use has seen a precipitous rise over the past decade [1, 4]. The remainder of this article addresses trends in the application and safety of these four well-studied cosmetic treatments.

Chemodenervation

BoNT is produced by the bacteria *Clostridium botulinum* and causes flaccid paralysis of target muscles by inhibiting acetylcholine release at the neuromuscular junction. The FDA has approved three different formulations of botulinum toxin type A: OnabotulinumtoxinA (Botox; Allergan Inc., Irvine, CA), AbobotulinumtoxinA (Dysport; Medicis Pharmaceutical Corp., Scottsdale, AZ), and the recently approved IncobotulinumtoxinA (Xeomin; Merz Pharmaceuticals, Frankfurt, Germany). Each formulation has the same mechanism of action but each has unique properties. For example, both

Table 1 Other cosmetic products and procedures

Product/ procedure	Effects	Evidence of efficacy	Potential risks/pitfalls
Bimatoprost 0.03% solution	Synthetic prostaglandin analogue Used for glaucoma treatment since 2001 Associated with longer, thicker, darker eyelashes	Demonstrated to be effective at enhancing eyelash growth in adults in a well-designed study [88]	Periocular hyperpigmentation has been reported [89] Theoretical risk of iris pigment changes
Cryolipolysis	Noninvasive method of fat cell destruction Takes advantage of fat cells being more sensitive to cold temperature than other cells	In porcine and human studies, has shown significant decrease in subcutaneous fat layer without damaging overlying skin [90] Patients with fat bulges ("love handles") may be best candidates	Larger studies need to be performed in order to better characterize its mechanism of action Obese patients and those with skin laxity will likely not benefit
Laser liposuction	Photothermal energy from laser "melts" fat to assist and enhance conventional tumescent liposuction	Some reports of improved collagen deposition and skin contraction [91]	Quality double-blinded, placebo-controlled studies yet to be performed [92]
Photodynamic therapy	Improved photoaged skin via enhanced collagen remodeling and production [93]	Small randomized studies on photoaged skin have shown success [94]	Many variables can affect the clinical outcome (eg, wavelength of light, sensitizer, dose, incubation, etc.) [94]
Radiofrequency (RF)	Noninvasive, nonablative RF device that delivers monopolar energy in the form of an electric current to generate heat in tissue [95] Thought to tighten tissue	Reports of tightening of facial skin and improvement in body shape [96]	Most patients develop erythema Effects are subtle and some patients may not respond Larger studies must be performed to establish safety and efficacy
High-intensity focused ultrasound therapy	Focused ultrasound concentrated in a defined subcutaneous area to produce fat lysis or skin tightening, while limiting damage to peripheral structures [97]	Rater-blinded prospective study has shown success for facial and neck tightening [98]	Intraoperative pain may be significant Dysesthesia and ecchymosis have been reported [99] Larger studies must be performed to establish safety and efficacy

OnabotulinumtoxinA and AbobotulinumtoxinA must be refrigerated during transportation and storage before dilution. On the other hand, IncobotulinumtoxinA may be stored at room temperature. Unit equivalence between products may also vary, and it seems that the most currently accepted dose conversion ratio for AbobotulinumtoxinA to OnabotulinumtoxinA is 2–3:1 (Allergan Inc., Irvine, CA) [32, 33].

Emerging Trends and Safety Considerations

Expanding the Anatomic Sites for BoNT

Currently, BoNT's only FDA-approved cosmetic indication is for glabellar lines. However, many practitioners routinely inject BoNT into many other areas on the face. For example, BoNT injections are now commonly used to lift the brow, widen the eyes, and change the shape of the jaw line [34•].

Injection of BoNT to different areas may cause undesirable paralysis of muscles. Brow ptosis and blepharoptosis are two of the more severe adverse events associated with chemodenervation in the upper face, and they were found to occur at a rate of 11% in a large case series [35]. Unwanted diffusion of the neurotoxin to the frontalis causes brow ptosis, and inadvertent diffusion through the orbital septum can cause a flaccid paralysis of the levator palpebrae superioris muscle, resulting in blepharoptosis [34•, 36]. Complications of chemodenervation of the lower face include mouth incompetence, drooling, asymmetry, the inability to purse the lips, and difficulties in speech [34•]. Injections

directly into the orbicularis oris or mental fold or those too close to the mouth can result in these adverse events [34•].

An understanding of periorbital anatomy and proper technique will lower the incidence of brow ptosis and blepharoptosis [36]. The rate of ptosis appears to be influenced by the skill and experience of the injector [34•, 36]. In order to avoid brow ptosis, Carruthers and colleagues suggest preinjection of the brow depressors and injecting the glabella and forehead in separate treatment sessions (SORT level C evidence) [34•, 37]. Blepharoptosis can be avoided by the use of higher concentrations and smaller volumes, with careful placement of the toxin 1 cm above the bony orbital rim and 1.5 cm lateral to the lateral canthus (SORT level C evidence) [34•]. It is also important to advise patients to avoid manipulation of the treated area for several hours following injection [34•]. Blepharoptosis can be managed with α-adrenergic agonist (apraclonidine 0.5% or phenylephrine hydrochloride 2.5%) ophthalmic drops twice a day to the affected side (SORT level C evidence) [36]. Complications associated with chemodenervation of the lower face can be avoided by the use of small doses of neurotoxin injected superficially and symmetrically [34•].

Topical BoNT for Patients with Needle Phobia

Injection of BoNT remains unattractive to certain patients who fear needles. Additionally, misplaced injections can result in unwanted effects in adjacent facial areas. A recent, double-blind, placebo-controlled, split-face randomized trial investigated the effects of topical BoNT on lateral canthal lines (LCLs) [38•]. This gel was applied under occlusion for 30 min and subjects demonstrated statistically significant greater improvement in LCLs than placebo patients ($P< 0.0001$). Equally as important, there was no significant difference in the severity or frequency of adverse events between treatment and placebo groups [38•]. Additional studies will be necessary to compare the efficacy of topical to injectable BoNT.

BoNT to Minimize Scarring After Scalpel-Based Surgery

There has been some interest in the use of BoNT as an adjunct in surgical interventions. It has been hypothesized that muscle relaxation induced by chemodenervation decreases the tension on the apposed edges to minimize scar formation [39]. A prospective, blinded, placebo-controlled study did show a statistically significant improvement in cosmesis and healing when toxin was injected into forehead musculature after wound repair from laceration or tumor extirpation [40]. Chemical denervation as a supplement to surgical scar revision has also been published [41], although the benefits of this have been challenged [42]. Additional studies in different regions of the face will help to validate whether paralysis of muscles of facial expression, which insert directly into the overlying dermis, improves appearance of scars.

Soft Tissue Fillers

Over 1 million STFs were injected in each of the past 2 years [1]. According to the FDA website, there are close to 20 FDA-approved fillers for wrinkles [43]. The most commonly used STFs are volumizers such as hyaluronic acid (HA) and biostimulators such as calcium hydroxylapatite and poly-L-lactic acid (PLLA) [44].

Emerging Trends

A Paradigm Shift from "Filling" Wrinkles to Restoring Volume and Youthful Proportions

The conceptual strategy for injection of STFs has evolved considerably in recent years. Initially, lines and wrinkles, such as the melolabial folds, were "filled" with product such as collagen. With increasing knowledge of facial anatomy (particularly an appreciation for the underlying facial fat pads) and a better understanding of processes leading facial aging, STF injection techniques have been revolutionized [45•]. Rather than simply filling wrinkles, injection of STFs now aims to restore youthful proportions and global volume of the face. Fitzgerald and Vleggaar [46•] elegantly review this conceptual change with their approach to volume restoration with PLLA.

Minimizing Pain with Injection

In order to lessen the pain experienced during STF injection, recent research has examined the effects of premixing STFs with lidocaine [47, 48]. These recent studies show that adding lidocaine to STFs decreases pain with injection without any difference in aesthetic results and/or the incidence of adverse events.

Injection of STFs to Novel Anatomic Locations and Novel Indications

Practitioners use STFs to rejuvenate a growing number of anatomic locations and for volume restoration associated with different medical conditions. Various STFs may be used for nonfacial volumization, such as the hands [49, 50], and products such as PLLA have also been used on the chest [51]. Fillers such as HA can be injected into areas of age-related volume loss in the lips [52] and nasojugal grooves (tear troughs) [53]. HIV lipoatrophy and midface

volume loss associated with aging may be corrected with STFs [54]. Finally, depressed scars from acne and varicella may also be treated with STFs [55].

Safety Considerations

Vascular Compromise

Vascular compromise is one of the most dreaded complications of STF injection. Vascular compromise occurs via two mechanisms: direct arterial embolization or by venous occlusion. The glabella is the classic location for skin necrosis after injections. Patients with vascular compromise report persistent, severe pain out of proportion to the procedure and present with blanching or violaceous discoloration [32, 56]. Alar nasal skin necrosis has also been reported secondary to arterial embolization from STF injected into the melolabial fold [57]. If this is suspected, the physician must immediately stop the injection. This should be followed by aspiration of the filler material, vigorous massage, and warm compresses (SORT level C evidence) [32]. On should also consider topical 2% nitroglycerine paste to improve blood flow by vessel dilation (SORT level C evidence). In the case of vascular compromise with hyaluronic acid fillers, hyaluronidase injection can dissolve the filler and restore blood flow (SORT level C evidence). Any subsequent skin breakdown can be treated with topical antibiotics and conservative debridement [56]. Systemic antibiotics may be necessary in more severe cases. In order to avoid vascular compromise, use 27- to 32-gauge needles, injecting the filler intradermally while withdrawing the needle, and use the smallest volume possible in small, discrete aliquots (SORT level C evidence) [56].

Nodules and Biofilms

Early-onset adverse events (3–14 days post-procedure) include inflammatory and noninflammatory nodularity [57]. Noninflammatory nodules often result from over-correction with a dermal filler or poor filler placement and may disappear within a few weeks [58•]. Instruct patients to gently massage the area and offer reassurance. Hyaluronic acid fillers dissolve with hyaluronidase, which can be injected for unwanted noninflammatory nodules [57, 58•].

Inflammatory nodules are erythematous, fluctuant, and painful. Granulomas and delayed inflammatory nodules are now thought to be infections due to delayed activation of a biofilm [59]. Biofilms, a complex aggregation of microorganisms marked by the excretion of an extracellular protective, adhesive matrix, play an important role in STF complications [45•, 58•]. They are often difficult to culture and lead to increased antibiotic resistance [45•, 58•].

Painful, erythematous nodules should be treated as infections and require immediate and aggressive attention. Incision and drainage is recommended to expel the infected filler. The material should be sent for culture, but also polymerase chain reaction (PCR) and fluorescent in-situ hybridization (FISH) to identify the frequently elusive infectious agent [44], [58•]. Antibiotic regimens include 2–6 weeks of clarithromycin 500 mg or minocycline 100 mg twice daily, with the length of treatment dependent on the degree and duration of infection and whether the infected implant was removed either with hyaluronidase or surgically (SORT level C evidence) [59•]. The delayed complications of persistent erythema and telangiectasias secondary to STF placement may be treated with a 532-nm or 1064-nm laser [56].

In order to prevent the formation of a biofilm, it is important to avoid bacterial contamination of the filler implant. A formal sterile surgical preparation may prevent contamination of the filler. There is debate about the use of prophylactic antibiotics but it may be reasonable for large-volume, permanent filler injections [60]. There is a2-week period after filler placement when bacterial contamination can lead to the development of a biofilm [60]. During that time, needle injections near the implant, dental procedures, facial trauma, and infections must be avoided to decrease the risk of bacterial contamination and biofilm formation [60].

Laser Therapy

Laser systems are versatile tools that allow treatment of a broad range of cutaneous maladies. This article focuses the discussion on fractional laser technology, which has proliferated over the past 5 years. Fractional lasers attempt to bridge the clinical results of full skin ablation with the safety and minimal downtime of nonablative lasers. In its relatively short history, fractional laser technology has progressed rapidly, with nearly 30 commercially available fractional systems on the market [61].

Fractional laser systems may best be classified into two categories: nonablative fractional lasers (NAFL) and ablative fractional lasers (AFL). AFLs create microscopic, noncontiguous columns of thermal injury in the dermis, surrounded by zones of nonspecific thermal damage and normal tissue [62•]. NAFL therapy confines the thermal injury to the papillary and upper reticular dermis while sparing the epidermis [63]. Fractional technology allows for faster healing, as unaffected skin cells quickly heal the areas of nearby injured tissue [62•]. This leads to fibroblast activation and synthesis of new collagen [63]. NAFLs are associated with less post-operative recovery time and fewer side effects, but require a higher number of treatments to

achieve the desired effect [64]. AFL therapy is more powerful than NAFLs, requiring fewer treatments, and is thought to have a lower adverse event rate than ablative, nonfractionated lasers [64].

Emerging Trends

Fractional lasers have been used for the treatment of cutaneous signs of photoaging, such as rhytides, dyspigmentation, vascular changes, elastosis, and actinic keratoses. Combining different laser and light systems may treat photoaging even more effectively [65]. Fractional lasers can also improve scarring that results from acne, surgery, and trauma [66•, 67]. NAFLs have been shown to improve surgical hypertrophic scars at a rate of 85% [68]. NAFLs also offer promise to treat notoriously refractory skin issues such as striae distensae [69] and melasma [70], although some studies show the contrary [71]. Finally, stimulation of hair growth is another avenue of investigation for fractional laser therapy [72, 73].

Safety

Many adverse events with laser therapy are due to professional errors such as incorrect operation of the laser, incorrect indication, and poor patient selection [67, 74]. It is recommended that laser skin resurfacing should only be performed by highly trained medical doctors [74, 75].

Common Events

NAFL treatment is associated with a low complication rate compared to other skin rejuvenation procedures [76]. Acneiform eruptions (1.8%), herpes simplex virus (HSV) outbreaks, and erosions all occur infrequently. Pretreatment with an antiviral therapy can significantly decrease the rate of HSV reactivation (SORT level C evidence) [67, 71]. Post-treatment acne and milia can be treated with tetracycline-based antibiotics [77]. Similarly, AFLs also have a favorable side effect profile when one body location is treated [64]. The complication rate of AFLs does appear to increase as the treatment surface area increases [64].

Post-Inflammatory Hyperpigmentation

Although it occurs less frequently compared to nonfractional lasers, post-inflammatory hyperpigmentation can occur in 1–32% of patients undergoing fractional laser skin resurfacing, especially in patients with darker skin types [67, 77]. Hyperpigmentation, the risk of blistering, and discomfort associated with the procedure can be reduced with the use of a cooling device (SORT level C evidence) [70]. Fractional lasers in darker skin should use higher fluences, lower density settings, and longer treatment intervals (SORT level B evidence) [63, 77, 78].

Scarring

Hypertrophic scarring rarely complicates AFL skin resurfacing; however, the neck is a well-recognized site for scarring, along with the periorbital area, chest, and hands [75, 77, 79]. This is thought to be secondary to excessive ablation and thermal damage in relation to the relatively small number of pilosebaceous units and poor vasculature that are necessary for wound healing [67, 77]. This thin skin may not be able to tolerate the energy or density of microablative zones that are used on the face [80]. Scarring in the periorbital region can lead to ectropion formation, which is more likely in those with a history of eyelid surgery [77].

Sclerotherapy

Sclerotherapy is injection of a liquid or foam sclerosant that interacts with a vessel wall, leading to a controlled thrombophlebitic reaction for the treatment of telangiectasias and reticular veins [81]. In the United States, the only FDA-approved sclerosants are sodium morrhuate, sodium tetradecyl sulphate, ethanolamine oleate, and polidocanol [82]. Other products such as iodine and chromate glycerin are also used off-label for sclerotherapy. Appropriate sclerosant selection and concentration are dictated by patient profile and vessel diameter [82]. Proper patient selection is paramount, as treatment of superficial veins due to great saphenous vein insufficiency leads to recurrence and patient dissatisfaction [83].

Emerging Trends

Foam Sclerotherapy

Although foamed detergents have been used in sclerotherapy for almost 70 years, there is an increasing amount of data being published regarding this modality [84]. Foam sclerotherapy is thought to be four times as effective as liquid sclerotherapy, due to its greater viscosity and greater surface area in contact with the endothelial lining of the vessel [81, 84, 85]. Foam sclerosants require less total volume and lower concentrations than those needed for an equivalent effect with liquid sclerosants. The best outcomes are seen in patients younger than 70 years of age, for variceal diameters less than 5 mm, and tributary veins [84].

Polidocanol

Polidocanol had been used for many years as a safe sclerosant but it only gained FDA approval in 2010. Its efficacy is equal to sodium tetradecyl sulphate but is associated with fewer complications [86].

Safety

Common Adverse Events

Sclerotherapy has a complication rate of 0.22% per session with liquid sclerosant and 0.58% with foamed sclerosants [87•]. Adverse events associated with sclerotherapy include transient visual disturbances (0.25–0.3% with sclerosing foam, 0.05%–0.07% with liquid sclerosant), deep and muscular thrombosis (0.09% and 0.2% for liquid and foam sclerosant, respectively), telangiectatic matting (2%–4%), headaches, dizziness, hyperpigmentation, and anaphylaxis [84, 87•]. The likelihood of each varies with the particular choice of sclerosant. Intra-arterial injection is the most feared complication and can cause skin or muscle necrosis [87•].

Thromboembolic

There is a concern that foam sclerotherapy can lead to paradoxical embolism from an occult patent foramen ovale, a common condition in the general population, with an incidence estimated at 27.3% [81]. There are a few cases of transient ischemic attacks and stroke in the sclerotherapy literature [87•]. The phenomenon is rare and currently there is no recommendation to screen for patent foramen ovale in the sclerotherapy patient population [81]. History of DVT or thrombophilia is considered a relative contraindication to sclerotherapy and necessitates the use of lower volumes and concentrations of the chosen sclerosing agent [84]. Compression stockings are recommended to prevent thromboembolic complications. Post-intervention compression stockings may also decrease the risk of hyperpigmentation, thrombophlebitis, and irritation [84]. Low-molecular weight heparin and oral anticoagulation may be indicated in select cases [84, 87•].

Conclusions

The rapidly changing field of cosmetic dermatology requires practitioners to remain abreast of current trends. Although early evidence suggests that many of these innovate trends are relatively safe and efficacious, careful patient selection, deep understanding of the relevant anatomy, proper technique, and patient education are of the utmost importance in order to decrease the incidence of adverse events.

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References

Papers of particular interest, published recently, have been highlighted as:
• Of importance

1. American Society for Aesthetic Plastic Surgery Cosmetic Surgery National Data Bank Statistics 2010. Retrieved October 9, 2011, from surgery.org
2. Sarwer DB, Crerand CE. Body dysmorphic disorder and appearance enhancing medical treatments. Body Image. 2008;5:50–8.
3. U.S. Census Bureau, 2010 Census website. Accessed November 19, 2011 from http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=DEC_10_SF1_QTP3&prodType=table.
4. American Society for Dermatologic Surgery (ASDS) website. Retrieved October 9, 2011, from http://asds.net/_ConsumerPage.aspx?id=942
5. Roenigk RK. Dermatologists perform more skin surgery than any other specialist: implications for health care policy, graduate and continuing medical education. Dermatol Surg. 2008;34:293–300.
6. Lee EH, Nehal KS, Dusza SW, Hale EK, Levine VJ. Procedural dermatology training during dermatology residency: a survey of third-year dermatology residents. J Am Acad Dermatol. 2011;64:475–83.
7. Tietje L, Cresap S. Is 'lookism' unjust? the ethics of aesthetics and public policy implications. Journal of Libertarian Studies. 2005;19(2):31–50.
8. Biddle JE, Hamermesh D. Beauty and the labor market. Am Econ Rev. 1994;84(5):1174–94.
9. Sarwer DB, Magee L, Crerand CE. Cosmetic surgery and cosmetic medical treatments. In: Thompson JK, editor. Handbook of eating disorders and obesity. Hoboken: Wiley; 2003. p. 718–37.
10. Edmonds A. The poor have the right to be beautiful: Cosmetic surgery in neoliberal Brazil. Journal of the Royal Anthropological Institute. 2007;13:363–81.
11. Swami V, Chamorro-Premuzic T, Bridges S, Furnham A. Acceptance of cosmetic surgery: personality and individual difference predictors. Body Image. 2009;6:7–13.
12. Crockett RJ, Pruzinsky T, Persing JA. The influence of plastic surgery 'reality TV' on cosmetic surgery patient expectations and decision making. Plast Reconstr Surg. 2007;120:316–24.
13. Sperry S, Thompson JK, Sarwer DB, Cash TF. Cosmetic surgery reality TV viewership: Relations with cosmetic surgery attitudes, body image, and disordered eating. Ann Plast Surg. 2009;62(1):7–11.
14. von Soest T, Kvalem IL, Skolleborg KC, Roald HE. Psychosocial factors predicting the motivation to undergo cosmetic surgery. Plast Reconstr Surg. 2006;111:51–62.
15. Brown A, Furnham A, Glanville L, Swami V. Factors that affect the likelihood of undergoing cosmetic surgery. Aesth Surg J. 2007;27:501–8.
16. Honigman RJ, Phillips KA, Castle DJ. A review of psychosocial outcomes for patients seeking cosmetic surgery. Plast Reconstr Surg. 2004;113:1229–37.

17. Cook SA, Rosser R, Salmon P. is cosmetic surgery an effective psychotherapeutic intervention? A systematic review of the evidence. J Plast Reconstr Aesth Surg. 2006;59:1133–51.
18. von Soest T, Kvalem IL, Roald HE, Skolleborg KC. The effects of cosmetic surgery on body image, self-esteem, and psychological problems. J Plast Reconstr Aesth Surg. 2009;62:1238–44.
19. Sarwer DB, Crerand CE. Body image and cosmetic medical treatments. Body Image: An International Journal of Research. 2004;1:99–111.
20. Conrado LA, Hounie AG, Diniz JB, et al. Body dysmorphic disorder among dermatologic patients: Prevalence and clinical features. J Am Acad Dermatol. 2010;63:235–43.
21. Kohn LT, Corrigan JM, Donnaldson MS. To Err is human: building a safer health system. national institute of medicine, committee on quality of health care in America. Washington: National Academy Press; 1999.
22. • Elston DM, Taylor JS, Coldiron B, et al.: Patient safety: Patient safety and the dermatologist. J Am Acad Dermatol 2009, 61:179-190. *This article addresses medico-legal issues for the dermatologist, data on patient safety in dermatology (particularly that relates to office-based surgery), and other practice-related topics pertinent to the dermatologist with the impending changes that will occur in the health care system*.
23. Coldiron BM, Healy C, Bene NI. Office surgery incidents: what seven years of Florida data shows us. Dermatol Surg. 2008;34:285–92.
24. Perlis CS, Campbell RM, Perlis RH, Malik M, Dufresne RG. Incidence of and risk factors for medical malpractice lawsuits among Mohs surgeons. Dermatol Surg. 2006;32:79–83.
25. Ellsworth WA, Basu CB, Iverson RE. Perioperative considerations for patient safety during cosmetic surgery – preventing complications. Can J Plast Surg. 2009;17(1):9–16.
26. • Starling J, Coldiron BM: Outcome of 6 years of protocol use for preventing wrong site office surgery. J Am Acad Dermatol 2011, 65:807-810. *This article demonstrates the successful integration of a correct surgery site protocol into a daily patient care model*
27. Food and Drug Administration. "The Sentinel Initiative: A national strategy for monitoring medical product safety." May 2008. http://www.fda.gov/Safety/FDAsSentinelInitiative/ucm089474.htm#approach. Accessed 11/19/2011.
28. Sobanko JF, Scheinfeld N, Kriegel DA. Liquid injectable silicone: should you implement it in your practice? Cosmetic Dermatology. 2006;19(8):5346.
29. Wheeler CK, Said H, Prucz R, et al. Social media in plastic surgery practices: emerging trends in North America. Aesth Surg J. 2011;31(4):435–41.
30. • Atiyeh BS, Rubeiz MT, Hayek SN: Aesthetic/Cosmetic surgery and ethical challenges. Aesth Plast Surg 2008, 32:829-839. *This article covers many of the ethical challenges that the cosmetic surgeon faces on a daily basis*.
31. Adeoye S, Bozic K. Direct to consumer advertising in healthcare: history, benefits, and concerns. Clin Orthop. 2007;457:96–104.
32. Berbos ZJ, Lipham WJ. Update on botulinum toxin and dermal fillers. Curr Opin Ophthalmol. 2010;21:387–95.
33. Karsai S, Raulin C. Current evidence on the unit equivalence of different botulinum neurotoxin A formulations and recommendations for clinical practice in dermatology. Dermatol Surg. 2009;35:1–8.
34. • Carruthers J, Carruthers A: Botulinum toxin in facial rejuvenation: an update. Obstet Gynecol Clin N Am 2010, 37:571-582. *Although published outside of the dermatologic literature, this is a concise but very informative update on the facial rejuvenating properties of BoNT*
35. Coté TR, Mohan AK, Polder JA, et al. Botulinum toxin type A injections: adverse events reported to the US food and drug administration in therapeutic and cosmetic cases. J Am Acad Dermatol. 2005;53:407–15.
36. Tremaine AM, McCullough JL. Botulinum toxin type A for the management of glabellar rhytids. Clin Cosm Invest Derm. 2010;3:15–23.
37. Ebell MH, Siwek J, Weiss BD, et al. Strength of recommendation taxonomy (SORT): a patient-centered approach to grading evidence in the medical literature. J Am Board Fam Pract. 2004;17:59–67.
38. • Brandt F, O'Connell C, Cazzangia A, et al.: Efficacy and safety evaluation of a novel botulinum toxin topical gel for the treatment of moderate to severe lateral canthal lines. Dermatol Surg 2010, 36:2111–2118. *This article presents a new and interesting formulation of BoNT that could drastically change the field*.
39. Flynn TC. Use of intraoperative botulinum toxin in facial reconstruction. Dermatol Surg. 2009;35:182–8.
40. Gassner HG, Brissett AE, Otley CC, et al. Botulinum toxin to improve facial wound healing: A prospective, blinded, placebo-controlled study. Mayo Clin Proc. 2006;81(8):1023–8.
41. Wilson AM. Use of botulinum toxin type A to prevent widening of facial scars. Plast Reconstr Surg. 2006;117:1758–66.
42. Venus MR. Use of botulinum toxin type A to prevent widening of facial scars. Plast Reconstr Surg. 2007;119(1):423–4. author reply 424.
43. Approved FDA Wrinkle Fillers. Retrieved on Oct 14, 2011 from, http://www.fda.gov/MedicalDevices/ProductsandMedicalProcedures/CosmeticDevices/WrinkleFillers/ucm227749.htm
44. Christensen LH. Host tissue interaction, fate, and risks of degradable and nondegradable gel fillers. Dermatol Surg. 2009;35:1612–9.
45. • Rohrich RJ, Pessa JE: The fat compartments of the face: Anatomy and clinical implications for cosmetic surgery. Plast Reconstr Surg. 2007,119:2219-2227. *This cadaveric study has made a significant contribution to the way in which facial aging is analyzed and addressed*.
46. • Fitzgerald R, Vkeggaar D: Facial volume restoration of the aging face with poly-l-lactic acid. Dermatol Ther 2011,24:2-27. *This review elegantly describes and illustrates facial rejuvenation with PLLA and should be read by both novice and experienced injectors*.
47. Marmur E, Green L, Buss M. Controlled, randomized study of pain levels in subjects treated with calcium hydroxylapatite premixed with lidocaine for correction of nasolabial folds. Dermatol Surg. 2010;36:309–15.
48. Brandt F, Bank D, Cross SL, et al. A lidocaine-containing formulation of large-gel particle hyaluronic acid alleviates pain. Dermatol Surg. 2010;36:1876–85.
49. Marmur E, Al Quaran H, De Sa Earp AP, et al. Five patient satisfaction pilot study of calcium hydroxylapatite injection for treatment of aging hands. Dermatol Surg. 2009;35:1978–84.
50. Palm MD, Woodhall KE, Butterwick, et al. Cosmetic use of poly-l-lactic acid: a retrospective study of 130 patients. Dermatol Surg. 2010;36:161–70.
51. Goldman MP. Cosmetic use of poly-l-lactic acid: My techniques for success and minimizing complications. Dermatol Surg. 2011;37:688–93.
52. Mandy S. Art of the lip. Dermatol Surg. 2007;33:521–2.
53. Lambros VS. Hyaluronic acid injections for correction of the tear trough deformity. Plast Reconstr Surg. 2007;120(6):74S–80S.
54. Narins RS. Minimizing adverse events associated with poly-L-lactic acid injection. Dermatol Surg. 2008;34:S100–4.
55. Beer K. A single-center, open-label study on the use of injectable poly-L-lactic acid for the treatment of moderate to severe scarring from acne or varicella. Dermatol Surg. 2007;33:S159–67.
56. Sclafani AP, Fagien S. Treatment of injectable soft tissue filler complications. Dermatol Surg. 2009;35:1672–80.

57. Kang MS, Prak ES, Shin HS, et al. Skin necrosis of the nasal ala after injection of dermal fillers. Dermatol Surg. 2011;37:375–80.
58. • Narins RS, Coleman WP, Glogau RG: Recommendations and treatment options for nodules and other filler complications. Dermatol Surg 2009, 35:1667-1671. *This is a thorough summary of the indications for dermal fillers and the complications and the treatment options of associated with fillers*.
59. • Rohrich RJ, Monheit G, Nguyen AT, Fagien S: Soft-tissue filler complications: The important role of biofilms. Plast Recon Surg 2010, 125(4):1250-1256. *This review article addresses soft tissue complications as a whole and focuses on the important role that biofilms have in delayed complications*
60. Monheit GD, Rohrich R. The nature of long-term fillers and the risk of complications. Dermatol Surg. 2009;35:1598–604.
61. Sobanko JF, Alster TS: Management of acne scarring: a comparative review of laser surgical approaches. Am J Clin Dermatol (in press)
62. • Sobanko JF, Alster TS: Laser treatment for improvement and minimization of facial scars. Facial Plast Surg Clin N Am 2011, 19 (3):527-542. *A useful guide and summary of laser therapy as it relates to scar remodeling*.
63. Chan NPY, Ho SGY, Shek SYN, et al. A case series of facial depigmentation associated with low fluence Q-switched 1,064 nm Nd:YAG laser for skin rejuvenation and melasma. Lasers Surg Med. 2010;42:712–9.
64. Campbell TM, Goldman MP. Adverse events of fractionated carbon dioxide laser: review of 373 treatments. Dermatol Surg. 2010;36:1645–50.
65. Tierney EP, Hanke CM. Recent advances in combination treatments for photoaging: review of the literature. Dermatol Surg. 2010;36:1–12.
66. • Brightman LA, Brauer JA, Anolik R, et al.: Ablative and fractional ablative lasers. Dermatol Clin 2009, 27:479–489. *This is a very thorough summary of the history, mechanisms of action, and indications for the numerous laser modalities*.
67. Tierney E, Mahmoud BH, Srivastava D, et al. Treatment of surgical scars with nonablative fractional laser versus pulsed dye laser: a randomized controlled trial. Dermatol Surg. 2009;35:1172–80.
68. Lin JY, Warger WC, Izikson L, et al. A prospective, randomized controlled trial on the efficacy of fractional photothermolysis on scar remodeling. Lasers Surg Med. 2011;43:265–72.
69. De Angelis F, Kolesnikova L, Renato F, et al. Fractional nonablative 1540-nm laser treatment of striae distensae in Fitzpatrick skin types II to IV: Clinical an histological results. Aesth Surg J. 2011;31(4):411–9.
70. Sherling M, Friedman PM, Adrian R, et al. Consensus recommendations on the use of an erbium-doped 1,550-nm fractionated laser and its applications in dermatologic laser surgery. Dermatol Surg. 2010;36:461–9.
71. Wind BS, Kroon MW, Meesters AA, et al. A. Non-ablative 1,550 nm fractional laser therapy versus triple topical therapy for the treatment of melasma: a randomized controlled split-face study. Lasers Surg Med. 2010;42:607–12.
72. Kim WS, Lee HI, Lee JW, et al. Fractional photothermolysis laser treatment of male pattern hair loss. Dermatol Surg. 2011; 37:41–51.
73. Beachofsky TM, Henning JS, Hivnor CM. Induction of de novo hair regeneration in scars after fractionated carbon dioxide laser therapy in three patients. Dermatol Surg. 2011;37:1365–8.
74. Greve B, Raulin C. Professional errors caused by lasers and intense pulsed light technology in dermatology and aesthetic medicine: preventative strategies and case studies. Dermatol Surg. 2002;28:156–61.
75. Biesman BS. Fractional ablative skin resurfacing: complications. Lasers Surg Med. 2009;41:177–8.
76. Graber EM, Tanzi EL, Alster TS. Side effects and complications of fractional laser photothermolysis: experience with 961 treatments. Dermatol Surg. 2008;34:310–07.
77. Metelitsa AI, Alster TS. Fractionated laser skin resurfacing treatment complications: a review. Dermatol Surg. 2010;36:299–306.
78. Kono T, Chan HH, Groff WF, et al. Prospective direct comparison study of fractional resurfacing using different fluences and densities for skin rejuvenation in Asians. Lasers Surg Med. 2007;39:311–4.
79. Abbasi NR, Dover JS. Fractional laser resurfacing: why all the fuss? Dermatol Surg. 2010;36:1–2.
80. Fife DJ, Fitzpatrick RE, Zachary CB. Complications of fractional CO2 laser resurfacing: four cases. Lasers Surg Med. 2009;41:179–84.
81. Palm MD, Guiha IC, Goldman MP. Foam sclerotherapy for reticular veins and nontruncal varicose veins of the legs: a retrospective review of outcomes and adverse events. Dermatol Surg. 2010;36:1026–33.
82. Sadick NS. Choosing the appropriate sclerosing concentration for vessel diameter. Dermatol Surg. 2010;36:976–81.
83. Palm MD. Commentary: choosing the appropriate sclerosing concentration for vessel diameter. Dermatol Surg. 2010;36:982.
84. Stucker M, Kobus S, Altmeyer P, et al. Review of published information on foam sclerotherapy. Dermatol Surg. 2010;36:983–92.
85. Njisten T, van den Bos RR, Goldman MP, et al. Minimally invasive techniques in the treatment of saphenous varicose veins. J Am Acad Dermatol. 2009;60:110–9.
86. Duffy DM. Sclerosants: a comparative review. Dermatol Surg. 2010;36:1010–25.
87. • Guex J: Complications of sclerotherapy: an update. Dermatol Surg 2010, 36:1056–1063. *This article is a helpful summary of the complications associated with sclerotherapy.*
88. Smith S, Faigen S, Whitcup SM, et al.: Eyelash growth in subjects treated with bimatoprost: A multicenter, randomized, double-masked, vehicle-controlled, parallel-group study. J Am Acad Dermatol 2011 Sep [Epub, ahead of print]
89. Priluck JC, Fu S. Latisse-induced skin hyperpigmentation. Arch Ophthalmaol. 2010;128(6):792–3.
90. Avram MM, Harry RS. Cryolipolysis for subcutaneous fat layer reduction. Lasers Surg Med. 2009;41:703–8.
91. Goldman A, Gotkin RH. Laser-assisted liposuction. Clin Plast Surg. 2009;36:241–53.
92. Zelickson BD, Dressel TD. Discussion of laser-assisted liposuction. Lasers Surg Med. 2009;41:709–13.
93. Issa MC, Maceira J, Vieira MC, et al. Photorejuvenation with topical methyl aminolaevulinate and red light: a randomized prospective clinical, histopathologic and morphometric study. Dermatol Surg. 2010;36(1):39–48.
94. MacGregor JL, Dover JS. The evolving role of photodynamic therapy for the treatment of photoaged skin. Dermatol Surg. 2010;36:49–51.
95. Sukal SA, Geronemus RG. Thermage: the nonablative radiofrequency for rejuvenation. Clin Dermatol. 2008;26:602–7.
96. Anolik R, Chapas AM, Brightman LA, et al. Radiofrequency devices for body shaping: A review and study of 12 patients. Semin Cutan Med Surg. 2009;28:236–43.
97. Brown SA, Greenbaum L, Shtukmaster S, et al. Characterization of nonthermal focused ultrasound for noninvasive selective fat cell disruption. Plast Reconstr Surg. 2009;124:92–101.
98. Alam M, White LE, Martin N, et al. Ultrasound tightening of facial and neck skin: A rater-blinded prospective cohort study. J Am Acad Dermatol. 2010;62:262–9.
99. Gadsden E, Aguilar MT, Smoller BR, et al. Evaluation of a novel high-intensity focused ultrasound device for ablating subcutaneous adipose tissue for noninvasive body contouring: Safety studies in human volunteers. Aesth Surg J. 2011;31(4):401–10.