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REVIEW AESTHETIC

A Novel Approach to Structural Facial Volume Replacement

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Abstract Improved understanding of the anatomy and physiology of the aging face has laid the foundation for adopting an earlier and more comprehensive approach to facial rejuvenation, shifting the focus from individual wrinkle treatment and lift procedures to a holistic paradigm that considers the entire face and its structural framework. This article presents an overview of a comprehensive method to address facial aging. The key components to the reported strategy for improving facial cosmesis include, in addition to augmentation of volume loss, protection with sunscreens and antioxidants; promotion of epidermal cell turnover with techniques such as superficial chemical peels; microlaser peels and microdermabrasion; collagen stimulation and remodeling via light, ultrasound, or radiofrequency (RF)-based methods; and muscle control with botulinum toxin. For the treatment of wrinkles and for the augmentation of panfacial dermal lipoatrophy, several types of fillers and volumizers including hyaluronic acid (HA), autologous fat, and calcium hydroxylapatite (CaHA) or injectable poly-L-lactic acid (PLLA) are available. A novel bimodal, trivector technique to restore structural facial volume loss that combines supraperiosteal depot injections of volume-depleted fat pads and dermal/subcutaneous injections for panfacial lipoatrophy with PLLA is presented. The combination of treatments with fillers; toxins; light-, sound-, and RF-based technologies; and surgical procedures may help to forestall the facial aging process and provide more natural results than are possible with any of these techniques alone.

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Keywords Cosmetic techniques · Face · Poly-L-lactic acid · Rejuvenation · Skin aging

Increased understanding of the complex and dynamic changes that occur with facial aging has laid the foundation for adopting an earlier and more holistic interventional approach to facial rejuvenation. Although preventive strategies are commonplace in many medical arenas, facial aging prophylaxis, particularly the early treatment of aging signs before they progress, is a relatively new concept in cosmetic dermatology that attempts to delay or prevent surgical intervention.

We currently understand that age-related changes occur in all tissues and structures of the face and that changes in one area may cause a cascading effect in adjacent areas [27]. Additionally, there is growing recognition of the complex interplay between craniofacial structural remodeling, volume loss, and age-related skin changes. Consequently, methods that consider the entire face and its structural framework by using multiple available technologies and treatments can provide a more holistic approach and may forestall further deterioration.

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Table 1 Bimodal approach to panfacial volume restoration

Structural support	
Trivector approach	Minimizes patient discomfort
	Three injection access sites
	Fanning and threading technique
Supraperiosteal depot injection	Structural platform for rejuvenation
	Replaces musculoskeletal volume loss
	Replaces structural fat pad volume loss (temporal, preauricular, lateral/mid-cheek, mandibular fat pads)
Lipoatrophy	
Deep dermal/subcutaneous injection	Correction of all areas of clinical lipoatrophy
	Allows for customization of results
	Potential for improved skin quality

This article provides an overview of age-related changes associated with the skin and the underlying structural framework of the face, and also describes the devices and techniques that can be used both prophylactically and for the reversal of facial aging, including a novel bimodal, trivector technique for volume replacement (Table 1).

The Aging Face

Facial aging is characterized by a myriad of features including upper eyelid dermatochalasis, dyschromia, wrinkles, protruding eyelid fat, brow ptosis, and volume changes [41]. These features result from a complex interplay of anatomic, histologic, and physiologic changes that affect the bone, ligaments, fat, and skin in the upper, middle, and lower portions of the face (Fig. 1) [16, 25].

Alterations in Volume and Structural Support

Volume loss in the aging face results from both craniofacial remodeling and atrophy of superficial and deep fat [25]. Recent studies have highlighted the significant loss of craniofacial skeleton volume [52, 63], and a recent review of the craniofacial remodeling literature found consistent age-related contour changes of the orbit, anterior maxilla, and mandibular body, as well as decreased dimensions of the glabellar, pyriform, and maxillary angles [62].

Because the bony elements of the face provide the framework on which the soft tissues rest [64], craniofacial changes have a substantial impact on facial features and overall aesthetics. For instance, the increase in mandibular angle observed with aging may cause blunting or loss of definition of the lower border of the face [64], and an increase in the pyriform aperture can lead to an appearance of nose elongation and a drooping nasal tip [63]. Additionally, midfacial bone loss may exacerbate the nasolabial fold by reorienting the malar fat pad medially and inferiorly [63].

In addition to craniofacial remodeling, growing evidence shows that remodeling of facial fat occurs with time and contributes to the appearance of the aging face [34, 57]. In the youthful face, deep and superficial fat are balanced, creating an even distribution of facial fullness [17]. As the face ages, redistribution and descent of facial fat pads contribute to the older appearance (Fig. 1) [34, 57].

Groundbreaking studies have recently elucidated the partitioning of superficial and deep facial fat into discrete anatomic compartments, or fat pads, confirming that facial fat is not one confluent mass [54, 56, 57]. Deep fat is the foundation for overlying subcutaneous fat compartments [57], and age-related changes in the volume and positioning of these compartments can lead to predictable changes in the appearance of the face [54]. For example, volume loss in the deep medial cheek fat pads diminishes anterior projection of tissue, leading to "pseudoptosis" and the appearance of nasolabial folds [54]. This redistribution of facial fat causes atrophy in certain areas and hypertrophy in others [17]. Atrophy occurs in the periorbital, forehead, buccal, temporal, and perioral areas, leading to sagging due to the relative excess of remaining skin [17].

Redistribution or loss of volume in the temporal, suborbital, and buccal fat pads leads to age-related changes in multiple facial areas including the cheeks, temples, and nasolabial folds. Superficial and deep volume loss can lead to the manifestation of wrinkles, folds, and lines on the surface of the aging face, and methods aimed at restoring the lost volume in both the superficial and deep structural supportive features may provide benefit in impeding the facial aging process.

Alterations in the Skin

Although the cellular and molecular mechanisms involved in skin aging are complex and the processes are influenced by a range of both intrinsic and extrinsic factors, sun exposure (photoaging) has been identified as a key cause, with degradation of the collagen matrix as a key mechanism.

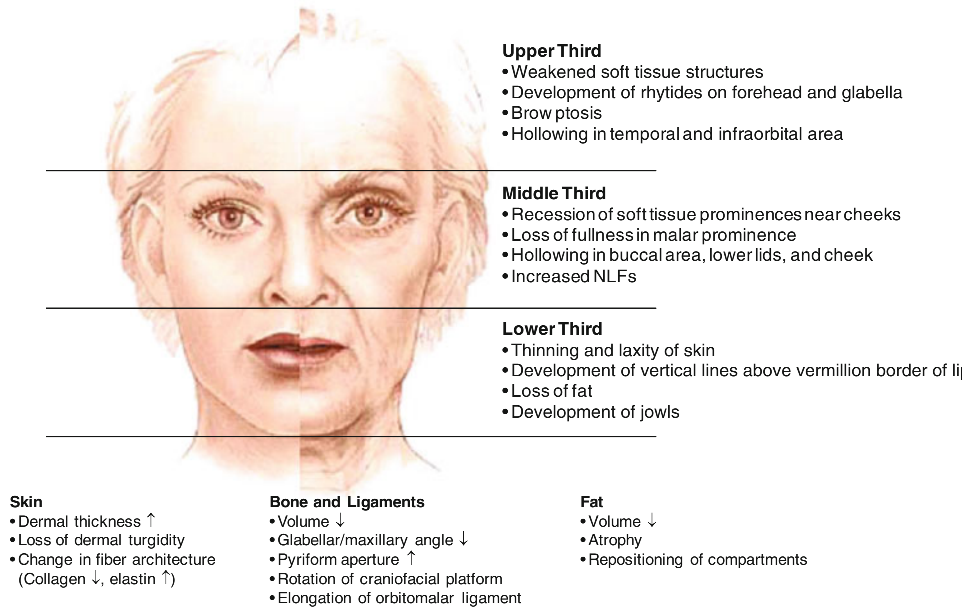

Fig. 1 Age-related changes in facial tissues. *NLFs* nasolabial folds. Adapted from [16]

The importance of maintaining collagen stability was recently reviewed by Fisher et al. [21]. Briefly, as the skin ages, the structural integrity of the dermis is impaired due to enzymatic degradation of the collagen by matrix metalloproteinases [21]. The resulting fragmented collagen can no longer provide the structural support needed for fibroblast attachment, causing the fibroblasts to collapse [21]. The balance between collagen synthesis and production of collagen-degrading enzymes shifts toward degradation, and the aging process continues to advance in a sustained cycle of collagen loss and fibroblast collapse [21]. The described process results clinically in dynamic and static wrinkles, dermal atrophy, and elastosis [28]. Further signs of aging are dyschromic manifestations such as senile lentigines, patchy hyperpigmentation, telangiectasia, and erythema, as well as rough skin and enlarged pores [39, 73].

Approaches to Facial Aging Prophylaxis

Given the role of collagen degeneration, fibroblast collapse, and volume loss in the progression of the aging face, an approach to prophylaxis should seek to protect against environmental exposure, stimulate collagen synthesis and cell turnover, and address dyschromia, wrinkles, and both superficial and deep structural volume loss before they become significant. Hence, the key elements of our approach to facial aging treatment are protection, promotion of cell turnover, collagen stimulation/remodeling, muscle control, and volume replacement. To that end, an abundance of treatments are available, with the choice of individual and combination therapies influenced by patient considerations, desired clinical effect, ease of use, reliability, safety, and cost. These options are summarized in Fig. 2 and described in the following sections.

Topical Protection and Stimulation

Protection against the cumulative effects of ultraviolet (UV) exposure and other extrinsic factors is paramount to preserving the appearance of youthful skin. Stable broad-spectrum sunscreens are a mainstay for protecting the skin from UVA and UVB radiation. In addition, topical formulations containing antioxidants such as vitamins C and E [12], resveratrol [1], idebenone [45], coffeeberry [6], or superoxide dismutase [42] may help to protect the skin by scavenging free radicals. They can provide important benefits for the skin, including protection against UV-induced erythema, hyperpigmentation, and photoaging. Cell regulatory molecules such as retinoids have been shown to inhibit the induction of matrix metalloproteinases and may therefore protect against collagen fiber degradation [20–22]. Topically applied actives such as aminoguanidine may protect the skin from the formation of age-related advanced glycation end products [50] that lead to discoloration [46] and collagen damage [49, 50]. Additionally, topical peptides have shown benefit in reducing facial lines and wrinkles, possibly by stimulating collagen production [38, 55].

Muscle Control

Botulinum toxin type A is an established treatment for the lines, furrows, soft tissue malposition, and degeneration of facial shape associated with facial aging by controlling hyperdynamic muscle activity through local chemodenervation [19]. Furthermore, botulinum toxin type A also may

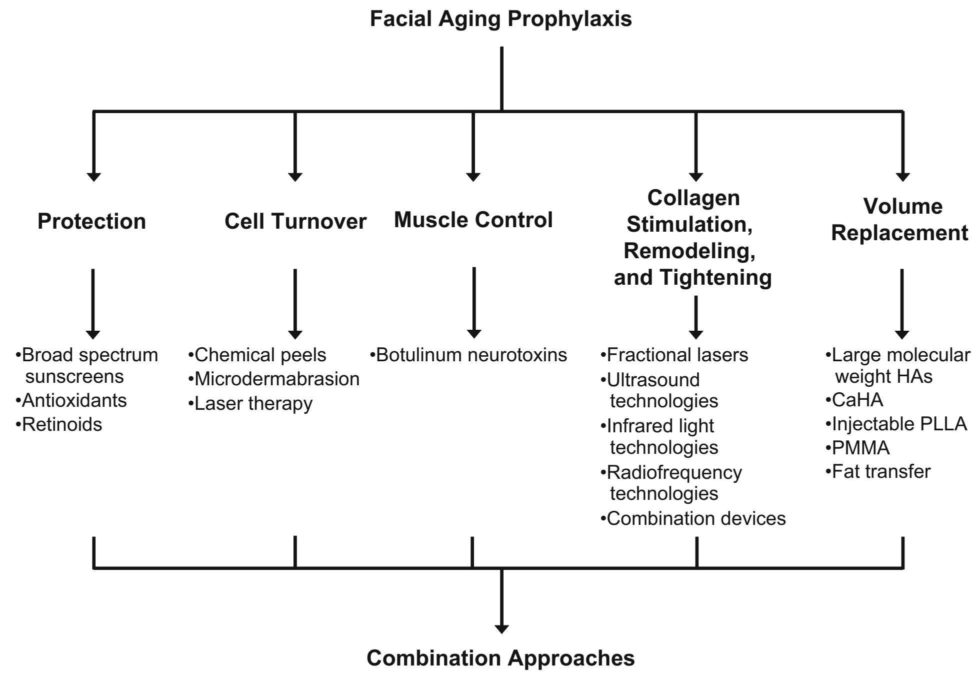

Fig. 2 Structural approach to age rejuvenation. *CaHA* calcium hydroxylapatite, *HA* hyaluronic acid, *PLLA* poly-L-lactic acid, *PMMA* polymethylmethacrylate

aid in facial line prevention if initiated at an earlier age and if regular treatments are sustained [7, 14]. The toxin prevents the release of the neurotransmitter acetylcholine at the peripheral nerve endings, generating a temporary denervation and relaxation of muscles for 16–24 weeks [29].

Cell Turnover

Epidermal turnover is essential for resurfacing and improving skin pigmentation and textural changes. Chemical peels are effective resurfacing tools that can treat superficial to moderate rhytides and dyschromia by decreasing corneocyte adhesion [36]. Microdermabrasion is an effective alternative, particularly for patients who have not yet experienced profound degenerative changes of aging [37]. This technique improves the appearance of fine wrinkles and dilated pores while increasing epidermal thickness and improving elastosis [37].

Laser micropeeling is a new method for superficial ablation up to 50 μm. A recent randomized clinical study based on a variable-pulse erbium:yttrium–aluminium-garnet (Er:YAG) laser with a wavelength of 2,940 nm has demonstrated a reduction in dyschromia and only minimal postprocedure erythema [66]. The benefits of this method are its tolerability and high patient satisfaction with limited downtime [15].

Collagen Stimulation and Remodeling

Dermal changes and collagen loss can be addressed via a number of devices based on a range of physical methods including light, radiofrequency (RF), and more recently, ultrasound. Additional devices include the combined use of these technologies.

Whereas devices for collagen stimulation target the fibrous network of the papillary dermis to correct collagen loss as well as glycosaminoglycan and elastin disorganization, devices for skin tightening involve heat-induced structural changes in the deep dermis and subcutis that cause the fibers to contract while retaining tensile strength. The heat-modified tissues undergo remodeling via fibroplasia, extracellular matrix production, and new collagen deposition, leading to skin tightening and gradual dermal thickening [59].

Collagen-stimulating devices are mainly premised on laser-based platforms and can be divided further into ablative and nonablative as well as fractional and nonfractional categories [2]. With fractional laser devices, the fractionated laser light causes thermal tissue damage and necrosis in targeted microscopic treatment zones while sparing the surrounding tissue [9]. Healing begins within 1 week, and replacement of the epithelial cells as well as expulsion of necrotic tissue ensues with a minimal inflammatory reaction [9].

Ablative fractional lasers have a higher affinity for water and ablate micro-columns of tissue including the stratum corneum, whereas nonablative fractional lasers result in column-like denaturation of the dermis and epidermis and an intact stratum corneum [10].

Good results in collagen stimulation can be expected with the 1,064- [68], 1,320- [67], and 1,440-nm neodymium

(Nd):YAG lasers or the 1,410- and 1,550-nm Er:glass fiber lasers [60]. Multiple clinical studies show improvement in rhytides when high-power micropulses, high repetition, and large spot size are used to obtain bulk heating.

To treat deeper wrinkles and skin laxity, light-based devices need wavelengths that are strongly absorbed by tissue water, such as the 10,600-nm carbon dioxide (CO_2), the 2,940-nm Er:YAG, or the 2,790-nm erbium:yttrium scandium gallium garnet (Er:YSGG) laser [48]. These have the ability to penetrate deep into the dermis and thermally ablate controlled layers of tissue [48]. Compared with CO_2 lasers, Er:YAG [4] and Er:YSGG lasers have less severe side effects and faster overall healing times due to their more precise ablative quality with minimal thermal damage to the surrounding tissues.

Ablative laser rejuvenation often results in postoperative hyper- and hypopigmentation as well as scars [40]. Therefore, fractional, partly ablative resurfacing has become more popular because of its shorter recovery time and lower risk for these adverse events.

Unipolar, bipolar, and multipolar RF devices deliver electrical energy directly to the skin, causing heat due to impedance of the tissue, which results in collagen contraction and thereby immediate skin tightening [5, 59]. Subsequent remodeling, reorientation of collagen bundles, and formation of new collagen due to wound healing [74] are achieved during the months after the treatment [11]. Known complications include discomfort, persistent erythema, nodularity/panniculitis, burns, and dermal adhesions.

Electromagnetic fields also have been shown to stimulate collagen synthesis [65], and a new device combines multipolar RF with magnetic pulses. The benefits of this platform are lower overall energy, increased safety, and no need for pretreatment preparation and topical cooling agents. Although experience with this approach is limited, results from a small pilot study suggest that RF-based technologies may be safely combined with volume replacement.

Another new device uses focused intense ultrasound energy to create small inverted cone-shaped zones of thermal coagulation within the ultrasound beam, leaving the surrounding tissue unaffected [3, 31]. The ultrasound field vibrates tissues, causing friction between molecules and secondary generation of heat, resulting in histologic evidence of collagen denaturation in the dermis and sparing the overlying epidermal layer [3, 31]. A study investigating the safety and efficacy of this device for facial skin tightening found that a single treatment of the forehead produced an average brow height elevation of nearly 2 mm and that it is a safe system with very little discomfort [3]. Adverse events include transient redness and swelling immediately after treatment and, more rarely, elevated white linear wheals [3].

Volume Replacement

As described earlier, volume is lost both in the dermis and in the deep structural and supportive elements of the face. Consequently, it is important to address both of these layers in a holistic approach to facial aging. Strategies for augmenting lost volume in the soft tissues include the use of injectable fillers such as hyaluronic acid (HA) derivatives, autologous fat transfer, or injectable biostimulatory fillers such as calcium hydroxylapatite (CaHA), injectable poly-L-lactic acid (PLLA), and polymethyl methacrylate (PMMA).

Hyaluronic acid is glycosaminoglycan and a natural compound of the extracellular matrix. Clinicians can differentiate HA fillers by their mechanical properties and duration as a function of their cross-linking density [18].The resulting strength of the gel mainly determines the clinical application of the filler. Strong gels have a high lifting capacity and can be used for deep wrinkles and folds, whereas weak gels have a low viscosity and can be used for very fine wrinkles and mesotherapeutic approaches.

As a nonantigenic, nonirritating, nontoxic agent, CaHA is identical to the inorganic constituent of teeth and bone in its chemical composition. After injection, the small CaHA particles are fixed in place via thin connective tissue without causing a reaction in the surrounding area, evidence of migration, or evidence of heterotopic bone growth [69]. After 18 months, the microspheres begin to degrade into metabolites consisting of calcium and phosphate ions [43]. In addition to use in facial augmentation, CaHA is particularly suitable for the treatment of volume loss in the hands because it produces a smooth and natural-looking result with only some temporary swelling as a side effect [30].

Poly-L-lactic acid is a biocompatible, biodegradable, immunologically inert, semipermanent soft tissue filler. Placed into the reticular dermis and subcutaneous tissue planes, where it lasts up to 2 years or more, PLLA stimulates local fibroblasts to promote neocollagenesis [32]. Its efficacy has been shown for the treatment of facial and nonfacial areas including the hands, neck, and chest [44, 51]. Common adverse events associated with PLLA use are ecchymoses, edema, pain, pruritus, inflammation, nodules, and hematomas [53].

Whereas HA, CaHA, and PLLA are temporary dermal fillers, PMMA is a nonresorbable, permanent filler. Composed of 20 % PMMA microspheres in 3.5 % bovine collagen, PMMA is FDA approved in the United States for the treatment of nasolabial folds. Off-label use of PMMA has been reported for several other facial lines including glabellar frown lines, upper lip lines, and mouth corners [35]. Although the collagen component is degraded over time, the PMMA microspheres are permanent and cannot be reversed without excision [33]. Common side effects are contour irregularity or nodules shortly after injection, as well as granulomatous reactions months or years after injection [13].

Consensus guidelines and details regarding the selection and application of these products can be found in recently published reviews [23, 24]. Whereas HAs, CaHA, and PMMA are primarily used for wrinkle and local volume augmentation, injectable PLLA is used for panfacial volume augmentation and general rejuvenation, although it is not well suited to address fine rhytides or lip volume. Additionally, HAs, CaHA, and PLLA are appropriate for nonfacial usage, including rejuvenation of the hands and chest.

To address volume loss in craniofacial support, alloplastic implants have traditionally been used but are not free of risk because bleeding, hematoma, seroma, fistula, pain, and persistent inflammation can occur. Moreover, infections appear in 1–3.8 % of patients receiving silicone implants [8, 58].

Nevertheless, the biostimulatory filler, injectable PLLA, has recently been applied to augment craniofacial support through the use of supraperiosteal injections [26, 72]. Injectable PLLA is a biocompatible volumizer well suited for panfacial volume restoration, with duration of up to 36 months and natural-appearing results [61, 70]. Injectable PLLA replaces lost collagen by increasing fibroblastic activity and stimulating collagen synthesis, which thereby begins gradually to restore volume, leading to the refinement and smoothing of shallow to deep facial wrinkles and folds [32, 71].

Injectable PLLA is versatile and can be used in multiple ways. Deep dermal/subcutaneous injections can be used to strengthen the dermis and address dermal lipoatrophy. It also can be used to mimic lost fat pad volume, or if placed supraperiosteally, it can be used to simulate bone volume [26]. Based on these versatile properties of injectable PLLA to correct the underlying causes of facial aging such as collagen loss and both superficial and deep structural volume depletion, we developed a bimodal technique for restoring facial volume that uses supraperiosteal injections to address depletion of the deep structural and supportive tissues of the face together with deep dermal/subcutaneous injections to treat dermal lipoatrophy of the more superficial tissues. This novel approach, described in the following sections, uses a trivector injection method for supraperiosteal product deposition.

The Bimodal Technique for Panfacial Volume Restoration

The first step to the bimodal technique involves supraperiosteal injections of injectable PLLA for the purpose of restoring lost volume in the deep structural layers of the upper, middle, and lower face to provide a structural platform. The supraperiosteal placement is used to mimic the volume lost in the supportive temporal, preauricular lateral cheek, mid-cheek, and mandibular fat pads and to address musculoskeletal atrophy.

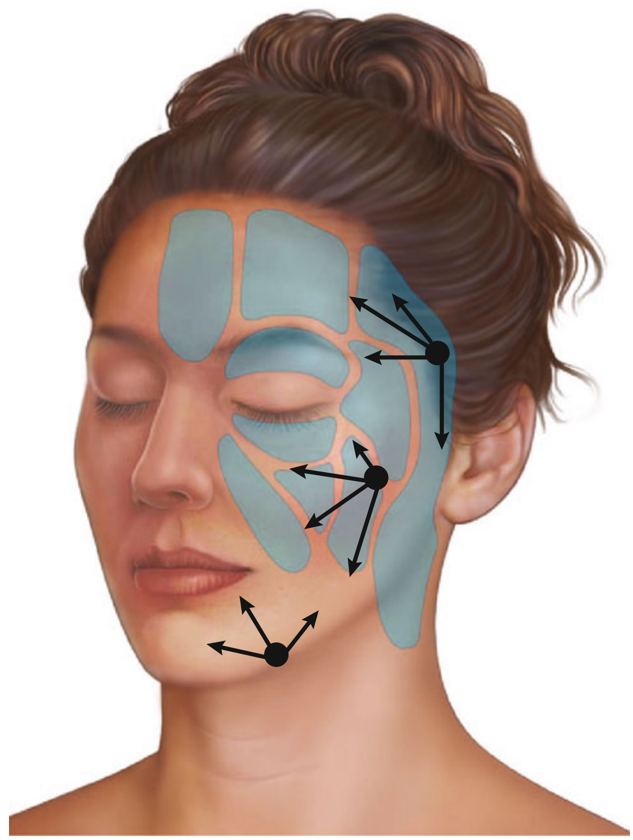

Fig. 3 Trivector injection approach for structural volume restoration [56]. Three injection access points are used to minimize patient discomfort during supraperiosteal placement of injectable poly-L-lactic acid (PLLA) for restoration of lost volume in the deep structural layers of the upper, middle, and lower face. *Green-shaded* areas indicate subcutaneous fat compartments. Adapted with permission from [56]

The novel technique minimizes patient discomfort through the use of three injection access points: (1) the temporal fossa to address forehead atrophy and brow ptosis, (2) the midface to treat the tear-trough, infranasal, and malar fat pad areas, and (3) the jaw line to address the mandibular angle, maxilla, and marionette lines (Fig. 3) [56].

The technique is termed the “trivector approach” to structural volume restoration in the face. The amount of product may vary for the depot injections, but in general, a small face with moderate volume loss requires a 1–2-ml temple, a 2–4-ml cheek, and a 1–2-ml perioral area [26]. The total amount of product can be divided into aliquots for the depot injections [26]. In fanning from an injection point, it is important to avoid multiple deposits at the apex of the fan [27].

Once the structural platform has been reinforced using the trivector approach, areas of dermal lipoatrophy are treated via deep dermal/subcutaneous injections in the next step of the bimodal technique. The goal of these injections is full customization of the volumetric filling in accordance with individualized desired outcomes and patient preferences.

The injections should be performed using a 27-gauge needle (0.5, 1.0, or 1.5 in.) at a 30–40° entry angle. A reflux maneuver to avoid blood vessels and a tunneling technique should be applied in a cross-hatch pattern in the lower face [26]. Injectable PLLA (0.1–0.2 ml per injection site) should be deposited at the subdermal junction, avoiding areas above hypermobile muscles. To ensure even product distribution, the injected area should be massaged after every two or three injections and at the end of treatment, and patients should be instructed to massage the injected areas for 5 min five times per day for 5 days after the procedure [27].

Augmentation of the temple area should use the periosteal, depot injection technique, and although injections around the orbits also use periosteal placement, they should not be attempted without sufficient training. In the lower face, combined supraperiosteal and subcutaneous injections are used via perioral injection for correction of the nasolabial folds and marionette lines, and injections to the malar eminence serve to restructure the fat pad. The malar augmentation technique involves placement immediately below the zygomatic bony prominence, directly above the periosteum over the maxillary bone, with linear threading and retrograde deposition of product.

Considerations of the Bimodal Technique

Hands-on examinations are helpful before beginning or continuing a treatment program and should take into consideration the totality of the age-related changes in three dimensions, including superficial changes as well as deeper volume loss. These evaluations should begin with recognition of regional anatomic landmarks including musculoskeletal structures and fat pads. Then a careful assessment should be made of the changes in skeletal width and height, bone loss, both deep and superficial fat loss, and overall tissue quality. Palpation of the soft tissue can be useful in provoking weaknesses and folds or creases, thereby aiding in identifying key areas for correction [26].

An understanding of the anatomic location and age-related changes of the facial fat compartments can be used as a "roadmap" to guide clinicians as they evaluate the need for deep support through deeply placed facial injectables [57]. A detailed map of the key areas to be addressed should then be used to guide both the deeper supraperiosteal injections and the more superficial subcutaneous injections.

Because injectable PLLA acts gradually by replacing lost collagen, multiple treatments are used to yield incremental, natural correction. The process follows the paradigm of treat, wait, and assess [27]. Therefore, the treatment sessions are spaced 4–6 weeks apart to prevent overcorrection. After the first two treatments, an optional third treatment may be needed, depending on the progress of the results and the individual's desired degree of correction. Later treatment sessions may use less product than earlier treatment sessions. It is worth noting that to avoid overcorrection, the amount of product used at the initial treatment session is based primarily on the two-dimensional area to be addressed, with subsequent treatments used to gradually attain the ultimately desired degree of correction in the third dimension of depth or overall volume [27].

As an added benefit with the use of a facial aging treatment method, improvements in skin quality have been noted, in our practices and by others, after injections of PLLA [47]. A possible explanation for this phenomenon, which currently is under investigation, could be the collagen stimulation and dermal thickening that occur with this treatment.

In preparation for use, the product should be reconstituted and stored at room temperature at least 24 h before treatment, with gentle agitation immediately before injection to ensure even product distribution. Each vial is reconstituted to a final volume of 9 ml with sterile water plus 1–2 % lidocaine with or without epinephrine, if desired [27].

Figure 4 shows an example of global facial rejuvenation with injectable PLLA. Combining injectable PLLA treatment with other methods such as laser and RF devices or botulinum toxin injections can yield very natural-appearing results (Fig. 5). Our clinical experience has shown the following between-treatment intervals to be necessary after injectable PLLA treatment: 48 h before IPL treatment; 1 week before IR, RF, or ultrasound treatments; and 1 month before fractional laser treatment.

The described bimodal technique for panfacial volume restoration makes injectable PLLA one of the most useful tools in reversing the increased angularity and the loss of aesthetically pleasing ratios, smoothness, softness, and plumpness in the aging face. The keys to treatment success include supraperiosteal and deep dermal/subcutaneous injections, recognition of regional anatomic landmarks including fat pad compartments as guides for correction, minimized number of injections via the trivector approach, immediate and postprocedure massage, individualized treatment, and adequate dilution and incubation of

Fig. 4 Global facial rejuvenation with injectable poly-L-lactic acid (PLLA). **a**, **b** A 49-year-old woman treated twice with one 6 ml vial of injectable PLLA spaced 4 weeks apart. **a** Before treatment. **b** After treatment. **c–e** A 66-year-old woman. **c** Before treatment. **d** After four treatments with injectable PLLA spaced 4 weeks apart. Two 6-ml vials of injectable PLLA were used in the first and second treatments. One 6-ml vial of injectable PLLA was used in the third, fourth, and fifth treatments. **e** View 3 months after the fifth treatment with injectable PLLA. Photographs courtesy of Dr. N. Sadick

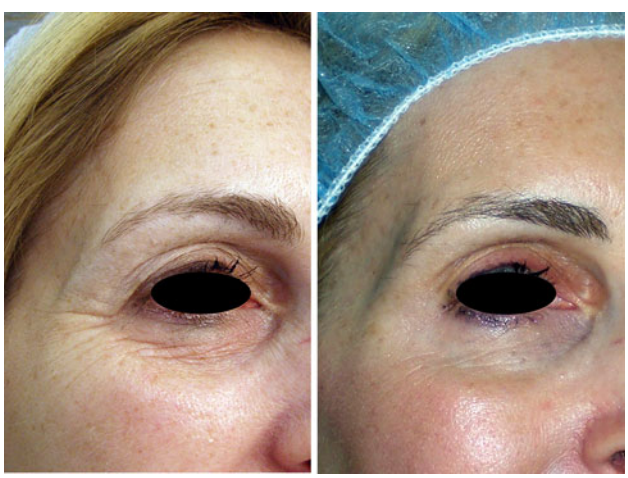

Fig. 5 Treatment with unipolar radiofrequency (RF) and injectable poly-L-lactic acid (PLLA) for a 52-year-old woman. The *left panel* shows the appearance of facial tissue before treatment. The *right photo* was taken 8 weeks after RF treatment. The patient received three treatments with one 6-ml vial of injectable PLLA per treatment. All injections were periosteal. The treatments were spaced 4 weeks apart. The patient also was treated with unipolar RF treatment (1.5 cm^2, 200 pulses total) 2 weeks after the last injectable PLLA treatment. Photographs courtesy of Dr. N. Sadick

injectable PLLA to ensure uniform product suspension and distribution.

Individualized Treatment and Earlier Intervention

Age-related changes of the face include the totality of the alterations in the superficial and deeper structural features. Because these changes vary from individual to individual, so must the approach in the choice of which age-related changes should be addressed and when as well as which techniques should be used and when. Although nearly any intervention may be effective in young patients with early morphologic changes, an approach that makes use of multiple treatment methods is likely to be necessary for older patients, in whom advanced changes have already occurred. For these older patients, varied treatment techniques in combination with surgical approaches can be very beneficial for an optimal outcome. Good synergistic effects can be seen by combining the discussed noninvasive and minimally invasive treatments with many surgical procedures including blepharoplasty, rhytidectomy, neck-lift, or brow-lift.

It is assumed that by beginning these less-invasive programs earlier, the facial aging process can be slowed down, but this remains to be evaluated, and prospective studies are needed.

Conclusion

Understanding the dynamic changes associated with the anatomy and physiology of facial aging as well as appreciating the degree to which these various changes have occurred in an individual patient allows for a customized treatment plan that combines multiple treatment methods such as light, RF- or ultrasound-based devices, injections of botulinum toxin, and volume augmentation with a filler such as HA, CaHA, or PLLA. A promising approach for volume restoration is the bimodal technique presented in this article that uses both deep periosteal injections and more superficial subcutaneous injections.

The discussed overall approach to facial aging treatment can lead to natural-appearing results, minimal downtime, a high level of patient satisfaction, increased cost effectiveness, and safety with minimal complications. A combination approach with invasive surgical procedures can enhance the effect and, in many cases, may be the best solution for the aging face.

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