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FACIAL PLASTICS: FACIAL SKIN REJUVENATION (PJ CARNIOL AND AE BRISSETT, SECTION EDITORS)

Contemporary Management of the Periocular Area

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Abstract
Purpose of Review To provide the reader with an overview of contemporary management of the periocular area.
Recent Findings There are various surgical and non-surgical techniques for periocular rejuvenation, with a growing number of minimally invasive approaches. Surgical interventions include blepharoplasty, ptosis repair, browpexy, brow lift, and autologous fat grafting. Non-surgical periorbital rejuvenation techniques include botulinum toxin type A, soft tissue fillers, ablative laser resurfacing, and platelet-rich plasma. Recent surgical techniques focus on volume preservation and enhancement, such as fat repositioning or grafting, selective resection of the orbicularis oculi muscle, and careful skin removal.
Summary Improved understanding of the pathophysiology of the aging face is driving recent periorbital rejuvenation techniques toward volume preservation and enhancement.

Keywords Periorbital rejuvenation · Blepharoplasty · Fat grafting · Browpexy · Brow lift · Ptosis repair

Introduction

Age-related changes in periorbital tissues, under-eye bags, and wrinkles play a significant role in the perceived age of an individual. According to the 2019 report of the American Society of Plastic Surgeons, eyelid surgery was the third most common cosmetic surgical procedure performed in the USA and continues to grow [1]. In addition to growing interest in surgical procedures, non-invasive or minimally invasive procedures throughout the face and body are also increasing, up by 237% from 2000 to 2019. The most popular procedure is botulinum toxin injections, which have increased by 878% during this time [1].

Periocular rejuvenation has shifted from removal and reduction in the past to lifting and volumization, due to our improved understanding of pathophysiology of the aging face. This paper will review the morphologic changes that occur with the aging process and discuss contemporary management options for the periorbital area.

This article is part of the Topical Collection on *FACIAL PLASTICS: Facial Skin Rejuvenation*

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Morphology of Periorbital Aging

Aging of the periorbital and midface complex is a dynamic, multifactorial, and inevitable process. Both endogenous and exogenous factors play a significant role in the aging process, including sun exposure, smoking, medications, alcohol, body mass index, genetics, and endocrinologic status. While the aging process is individual, there are several predictable changes that occur around the fourth decade of life.

Upper Lid and Brow

A youthful upper eyelid is thought to display a peak height between the pupil and the lateral limbus, a fullness that

smoothly transitions to the brow, and a well-defined eyelid crease. As we age, the upper eyelid thins with loss of elasticity, resulting in laxity and dermatochalasis, and the orbital septum weakens resulting in fat herniation. The preaponeurotic central fat pad tends to diminish in volume, while the medial fat pad tends to prolapse [2]. Deep to the upper eyelid fat pads, the levator aponeurosis can stretch, dehisce, or disinsert from the tarsus, contributing to involutional ptosis. Brow ptosis can either contribute to a heavy-appearing upper eyelid area, or conversely create a hollowed out upper eyelid area due to subcutaneous fat volume loss and increasing orbital rim prominence [3].

Lower Lid and Midface

The youthful lower eyelid has several characteristics including: an upward slant from medial to lateral canthus, lower lid position 1–2 mm above the inferior limbus, and a smooth, blended curve at lid-cheek junction. One sign of midfacial aging, the tear trough, is a hollow immediately below the lower eyelid fat prominences, which forms due to fixation of the inferomedial orbital septum to the arcus marginalis, absence of adjacent muscle and fat, and the presence of an osseocutaneous ligament, termed the tear trough ligament, which creates the tear trough [4–6].

Fat protrusion in lower eyelids also becomes more apparent with aging. "Double convexity deformity" describes the bulging lower eyelid fat superior to the tear trough hollow [7]. This can be due to pseudoherniation of orbital fat from weakened orbital septum and orbital fat expansion [8]. Midfacial fat descent, inferior orbital volume loss, and eyelid laxity contribute to lower lid displacement inferiorly, which results in a rounded eye appearance [9]. The orbital opening appears to enlarge vertically as the midface volume descends and pulls the septum and arcus marginalis inferiorly, exposing the tear trough and eventually the inferior orbital rim [8].

Periorbital and Eyelid Evaluation

A thorough and complete history and examination begins with assessment of patient desires, psychological readiness for cosmetic surgery (acceptance of surgical downtime, risks, and finances), presence of realistic expectations, and any ophthalmologic conditions or prior surgeries that could affect outcome. Review of old pictures of the patient at a more youthful stage to better evaluate their aging process and goals can be useful. Relevant past medical history including thyroid disease, cardiac disease, hypertension, anticoagulation use, renal failure, and coagulopathies should be reviewed [10, 11]. A temporary pre-operative hold on anticoagulants, if cleared by their medical doctor, can decrease intra- and post-operative bleeding complications. Preoperative examination should also assess presence of dryness, eyelid malposition or laxity, and globe position. Standard pre-operative photography should be taken in primary, up and down gaze, and lateral and oblique views.

The examination of the upper eyelid should look for skin discoloration and laxity, as well as the position and symmetry of the lid margins, lid crease height, orbital fat or lacrimal gland prolapse, and brow position. Sufficient skin between the brow and upper eyelid margin is necessary to allow for eyelid closure and to prevent post-operative brow descent; this amount of skin should be about 20 mm. The upper eyelid margin position can be assessed by measuring MRD1 (marginal reflex distance 1), which is the distance between the upper lid margin and the corneal light reflex in primary gaze (normal is 4 mm). Levator function dictates type of surgical repair and is defined as millimeters that the eyelid margin moves from downgaze to upgaze (greater than 10 mm is normal). In cases of unilateral blepharoptosis, the examiner should lift the affected eyelid to check for Hering's phenomenon.

The examination of the lower eyelid should identify excessive skin (dermatochalasis), herniation of fat, lid retraction, hypertrophied orbicularis oculi muscle, lid laxity, and festoons. Excess skin is evaluated by asking the patient to look up, and the amount of skin is assessed for either resection or laser resurfacing. Degree of herniation of medial, central, and lateral orbital fat pads should be noted. Lower eyelid retraction can be assessed by measuring MRD2 (marginal reflex distance 2), the distance between the corneal light reflex to lower eyelid margin (normal is 4–5 mm). Lower lid laxity (ability to pull lid more than 6 mm off of globe), snap back test, and eversion of lid aid in the decision for a concomitant lower lid suspension procedure.

Contemporary Management of Upper Eyelid and Brow Complex

The rejuvenation of the upper eyelid and brow includes several goals:

1. Removal of redundant skin for a more distinct eyelid contour
2. Removal or repositioning of excess fat, to create smoother appearance without hollowing
3. Correction of ptosis to open the eye and resolve visual obstruction
4. Restoration of brow to its normal anatomic position

Blepharoplasty

Blepharoplasty involves resection of redundant eyelid skin with or without fat. When performing skin removal, it is

Fig. 1 Patient with significant brow and eyelid ptosis (**a**) and following ptosis repair and endoscopic brow lift (**b**). Note the correction of glabellar ptosis and the return of the brow and its underlying fat to its original position above the superior orbital rim, providing a gentle slope toward the eye. (Photo courtesy of Anne Barmettler, MD.)

important to remember that aggressive skin excision can result in brow depression [12]. The orbicularis oculi muscle is usually preserved in order to reduce incidence of lagophthalmos and maintain volume [13]. The orbital fat in the upper eyelid is divided into a darker yellow central fat compartment and a paler, more prominent nasal fat compartment, with the lacrimal gland located temporally [3]. The nasal fat pad can be excised if marked herniation is present. However, trends have shifted away from aggressive fat removal as this can contribute to superior sulcus hollowing and a more aged appearance [13]. The central fat pad can be dissected into a pedicle and sutured into the superomedial eyelid to prevent superior sulcus hollowing and create a fuller, more youthful appearance. Lacrimal gland prolapse presents with a visible lump in the superotemporal orbit and may be repositioned into the lacrimal gland fossa in the frontal bone. The shape and height of the eyelid crease, or "tarsal show," should be adjusted for each patient, taking into account the patient's ethnicity, natural location of the crease from old photos, and patient preference as discussed during surgical planning.

Ptosis

Addressing eyelid ptosis is a critical component of upper eyelid management, as we know ptosis is associated with not just a decrease in peripheral vision, but can also contribute to a fatigued, aged, and weak appearance [14, 15]. Treatment is guided by etiology, severity, and levator muscle function. In the presence of a functioning levator, external levator advancement is often performed whereby the levator aponeurosis is advanced onto the tarsal plate, from an exterior approach. In 1961, Fasanella and Servat first described posterior approach for ptosis repair, involving removal of conjunctiva, Muller's muscle, and tarsus [16]. Putterman in 1975 then described a modification sparing the tarsus, the Muller's Muscle-Conjunctival Resection [17]. Both techniques are popular among oculoplastic surgeons and can achieve the goal of a more open eyelid and a more refreshed, energized appearance (Fig. 1).

Fat Grafting

In recent years, there has been a shift in the perception of fat in periorbital rejuvenation. Excess fat removal is now thought to contribute to a hollowed and therefore aged appearance, while fuller contours, such as a full lateral brow and smooth transition between the lower lid and cheek are thought to represent a youthful appearance. As a result, recent surgical techniques have focused on volume preservation and, in some cases, enhancement with fat grafting [3, 13, 18, 19•, 20, 21].

In fat grafting, harvested and processed adipose tissue is strategically placed to enhance volume and can be combined with upper or lower blepharoplasty. Autologous fat grafting is considered to be the ideal filler as it is long lasting and biocompatible with low allergenicity. The fat can be injected into a submuscular plane in the upper lid and just above the periosteum near the orbital rim and at the inferior orbital rim to address a tear trough deformity [19•]. Overcorrection may be performed to account for future resorption. This can be challenging and is one of the drawbacks of fat grafting, as there can be variable fat resorption resulting in an irregular appearance [22]. The periocular area can also be technically challenging to treat, due to the thin skin and lack of superficial fat, which can result in a nodular appearance of the graft [23]. Therefore, in this particular area, fractionated fat (fat broken into smaller bundles of cells) can be used to decrease lumpiness [19•, 24].

Brow Lift

Brow ptosis is frequently underdiagnosed and undertreated, contributing to a hooded appearance that will not be addressed by blepharoplasty alone. It is crucial to evaluate the brow position in all patients with upper eyelid concerns. In women, the optimal position of the brow is above the bony orbital rim; in men, the optimal position is at the superior orbital rim. There are various brow lift approaches, including direct, mid-forehead, pretrichial, coronal, temporal/lateral, endoscopic, browpexy, and non-surgical options.

A direct brow lift uses incisions directly above the eyebrows to excise excess tissue, providing the greatest degree of elevation per millimeter of tissue excised. However, the ptotic glabella cannot be addressed, and a conspicuous scar can develop [25]. This technique is useful for severe asymmetry from unilateral facial paralysis, thick brows, and deep forehead rhytids, or patients focused on function rather than appearance [26]. A mid-forehead lift utilizes an incision along a central forehead crease but has fallen out of favor because of the scar location.

A pretrichial brow lift utilizes an incision just anterior to the hairline, while a coronal incision brow lift uses an incision several centimeters behind the hairline. Advantages of both include bilateral elevation of tissues, correction of glabellar frown lines and forehead rhytids, and ability to alter hairline position if warranted. Since endoscopic brow lifts can elevate the brow and hairline with shorter recovery time and complications, coronal brow lifts have largely fallen out of favor. A temporal brow lift uses an incision behind the hairline at the temple and lifts only the outer one-third of the brow and forehead. Therefore, it does not address central brow or glabellar ptosis but has a shorter recovery time and less post-operative paresthesia.

An endoscopic brow lift has become the procedure of choice for many surgeons over the direct or coronal approach, as it is an effective and less invasive technique (Fig. 1) [27–29]. It utilizes three to five small incisions within the scalp and an endoscope for visualization of delicate nerves and vasculature. Patients typically have a shorter recovery time, less pain, and less post-operative numbness and alopecia compared to direct or more extensive techniques [30]. Several different fixation techniques for endoscopic brow lifting include fibrin glue, screws, bone tunnels, different sutures or wires, and absorbable implants [31]. There are no randomized controlled trials directly comparing techniques, and there is no consensus for which technique is the most durable. Disadvantages to this approach include a higher learning curve and additional equipment of an endoscope, light source, and video tower.

A browpexy aims to reposition the brows to their normal anatomical position with internal sutures to the underlying bone, with no effect on the forehead. Internal browpexy, or brow suture suspension, utilizes the blepharoplasty incision site to limit post-blepharoplasty eyebrow descent and provide a modest amount of lateral brow lift. This approach typically provides a limited result but does not result in an additional scar. External browpexy is a transcutaneous technique that uses a small incision just superior to the brow cilia [32]. This provides a modest lift with minimal scar, which is comparable to the lift from an internal browpexy [33].

Non-surgical brow lift by means of botulinum toxin or soft tissue fillers has become increasingly popular. The neurotoxin is injected into the depressor muscles of the brow to elevate the lateral brow. Advantages include lack of downtime, rapid response (3–5 days post injection), and overall safety profile [26]. However, the effect is limited to a minor lift and has to be repeated every 3–4 months. Soft tissue fillers can be injected in the lateral eyebrow to contour and subtly elevate the eyebrow tail. While effective, fillers carry risks of infection, nodules, tissue necrosis, and vision loss.

Another more recent technique is the thread, or barbed suture, lift. Two to four synthetic, barbed absorbable sutures are inserted approximately 1 cm behind the hairline to mechanically lift the lateral and/or medial brows and, theoretically, stimulate collagen production. However, the effect is short lived with most studies noting recurrence of laxity after 8 weeks to 1 year [34–37, 38•].

Non-surgical Skin Resurfacing

Non-surgical skin tightening of the periocular area can be achieved using chemical peels, mechanical dermabrasion, and laser resurfacing. Two of the most commonly used lasers for skin rejuvenation are the Erbium-doped yttrium aluminum garnet (Er:YAG) and carbon dioxide (CO_2) lasers. The CO_2 laser was the first to be used for skin resurfacing; it works by ablating the epidermis while applying heat to the dermis to induce collagen remodeling. The latest advancements in CO_2 laser use very short–pulsed light energy (ultrapulse) to inflict minimal heat damage. The Er:YAG is a newer technology that offers more precise energy delivery, allowing faster healing times but less dermal tightening [39]. Effective as a standalone treatment, laser ablation can also be combined with surgical treatments, like facelift and blepharoplasty, for additional skin tightening.

Role of PRP

Platelet-rich plasma (PRP) is obtained by centrifugation of the whole blood to obtain autologous platelets, which are then activated with calcium chloride and bovine thrombin to trigger release of growth factors. There are a few studies on PRP in the realm of periocular rejuvenation with mixed results. One study noted improved scar irregularity following intradermal PRP injection after blepharoplasty, while

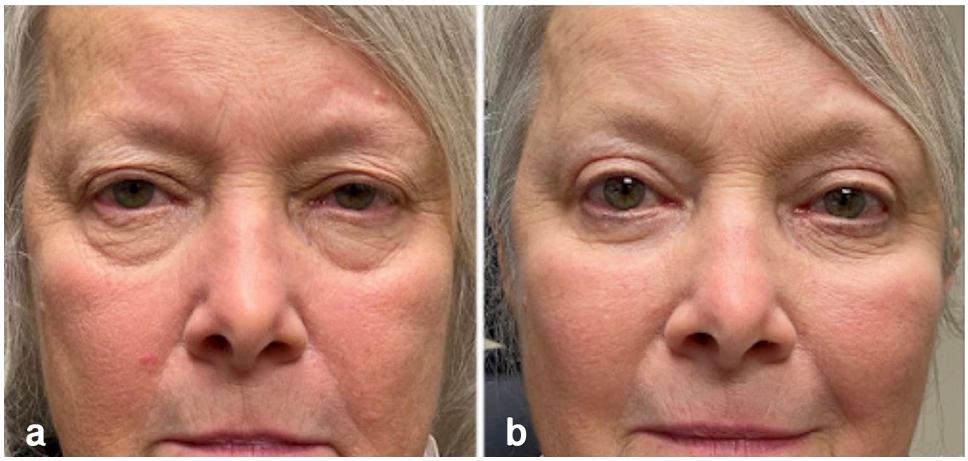

Fig. 2 Before (**a**) and after (**b**) of four lid blepharoplasty with lower eyelid fat transposition. Note the smoother lid-cheek junction resulting in more refreshed appearance. (Photo courtesy of Amina Malik, MD.)

another noted no significant wound healing after PRP gel was used after blepharoplasty [40, 41•]. PRP was also studied as an additive to fat grafts with the goal of improving graft retention, with some reports of success [42–44].

PRP can be combined with microneedling in the undereye area. Microneedling is a technique of introducing tiny sterile needles into the skin, effectively creating micro-channels which increase skin permeability to various compounds and increase collagen production. Microneedling was shown to increase the penetration of PRP into the dermis, where it can act synergistically to enhance collagen remodeling [45]. However, to date, there are no randomized controlled trials regarding PRP or microneedling, and existing studies lack objective outcomes.

Contemporary Management of the Lower Eyelid and Midface

There are several approaches to rejuvenation of the lower eyelid, including non-surgical and surgical. The main goals of lower eyelid rejuvenation are:

1. Smooth transition between lid-cheek junction
2. Elevated lid-cheek junction with natural convexity of the cheek
3. Restoration of the horizontal length of the eyelid fissure
4. Restoration of lower lid position to just inferior to the limbus
5. Lateral canthal attachment higher than medial canthal attachment

Surgical approaches include transconjunctival blepharoplasty (TCB) or infraciliary blepharoplasty, sometimes with lateral canthal or midface suspension. TCB has appeal due to lower rate of lower eyelid malposition, improved healing, and concealed incision. Fat excision does not address dermatochalasis but can be combined with skin incision to achieve optimal result [46]. Initial techniques of surgery focused on fat excision as the primary approach to address lower eyelid and midface contour abnormalities [47]. Over-resection of fat left a hollowed-out appearance that paradoxically created a more aged appearance. Trends have shifted in recent years from that of predominantly fat resection to transpositioning, starting with mobilization of nasal infraorbital fat over the inferior orbital rim to camouflage the nasojugal groove [48]. Now, many surgeons mobilize two or three fat compartments of the lower eyelid to conceal the infraorbital bony rim [49, 50]. This can be done via direct manipulation (redraping) of the pedicled fat from under the septum or fat repositioning of the whole fat septal unit. The fat can be repositioned in a supraperositeal or subperiosteal plane. Aesthetic results are reportedly comparable with either approach [51].

Redundant lower eyelid skin can be removed surgically or tightened via lasers and chemical peels. The amount of excess lower eyelid skin is assessed by having the patient open the mouth and look up. Skin removal should be conservative medial to the nasal limbus to avoid post-operative lid retraction. If skin removal is performed in the presence of lower eyelid laxity, a canthopexy suture can be placed with a vector posterior, superior, and lateral into the orbit to shorten and tighten the lower lid. This helps to prevent post-operative lid retraction and recreates a more youthful lateral canthal angle. Lower eyelid blepharoplasty allows for fat resection and transposition to soften tear trough deformities and correct infraorbital fat herniation, combined with skin tightening (Fig. 2). Overall, there is a shift toward enhancing the lower lid-cheek junction and preserving orbital volume.

Periorbital Dark Circles

Periorbital cutaneous changes are a source of esthetic concern in many patients, causing a fatigued and less youthful

Fig. 3 Before (**a**) and after (**b**) of injection of 1 syringe of under eye Restylane-L resulting in a smoother lid-cheek junction with decrease in prominence of under eye fat. (Photo courtesy of Amina Malik, MD.)

appearance [52]. The etiology of dark circles is multifactorial, including thin skin, hyperpigmentation, post-inflammation, vascular, and hormonal changes [53].

Treatment of periorbital dark circles depends on underlying etiology. There are a variety of laser treatments to improve periorbital hyperpigmentation including fractional ablative CO_2 laser resurfacing, intense pulsed light (IPL), long-pulsed laser, and Q-switched laser. For patients with hollowing due to age-related infraorbital volume loss, treatment options include a number of commercially available fillers or autologous fat transplantation (see "Fat Grafting") [54, 55]. Both techniques can effectively restore depleted volume to the tear trough, recreating a more youthful, smooth lower eyelid-midface transition zone. Fat autograft muscle injection (FAMI) is placement of small volumes of fat within muscles of facial expression. Long-term cosmetic results are due to adipocyte survival within these highly vascular recipient sites and subcutaneous fibrosis in response to grafted fat [55]. A study of fat transfer in 10 patients with under eye dark circles owing to thin skin showed a mean 78% improvement in lower eyelid discoloration and contour [56]. Drawbacks include variable "take" of injected fat, which may lead to visible lumps, as well as a risk of fat calcification.

Injectable hyaluronic acid (HA) dermal fillers have become increasingly popular due to ease of use, overall safety profile, lack of downtime, and immediate results. Although HA products are approved by the US Food and Drug Administration for correction of moderate to severe nasolabial wrinkles and folds, use in the under-eye area is currently off-label. Restylane-L (Medicis, a division of Valeant Pharmaceuticals, Inc, Scottsdale, AZ) is a medium-sized, particle-based, non-animal, bacterium-derived stabilized HA filler often used for under eye volumization. A number of injection techniques have been described, but the authors find that injecting a supraperiosteal bolus directly into the area underlying the tear trough and nasojugal groove using minimal injection points leads to excellent results (Fig. 3) [49, 55, 57]. Volumes of 0.4 to 1.0 cc per side can be used and gentle digital massage smooths product into place. While generally well tolerated, patients can develop post-injection edema and should be counseled about this potential adverse effect [58]. In such cases, hyaluronidase can be injected to dissolve the filler.

Festoons

Festoons occur when the orbicularis oculi muscle attenuates, creating an edematous drape inferior to the inferior orbital rim and over the malar eminence. Contributing factors include chronic inflammation, genetics, and skin laxity. When present, festoons can create a fatigued appearance and affect patients' self-confidence. When severe, festoons can cause visual field deficits on downgaze. Non-surgical options include radiofrequency thermoplasty, CO_2 laser resurfacing, chemical peels, doxycycline injections, and dermal fillers but have shown mixed results [59, 60]. Surgical approaches involve either direct excision or indirect redraping of the affected soft tissue [56]. The optimal treatment is yet to be determined but seems to involve a combination of elevation of soft tissue, tightening of orbicularis muscle, and removal of excess skin/muscle to address the multifactorial etiology of malar festoons.

Conclusion

Age-related changes in periorbital tissues include skin laxity, weakening of the orbital septum, volume loss, involutional ptosis, and brow descent. Rejuvenation of the upper eyelids and brow aims to remove redundant skin for a more distinct eyelid contour, manipulating fat for a fuller and smoother appearance, correcting ptosis to open the eye, and restoring the brow to its normal anatomical position. The goals of lower eyelid rejuvenation are to create a smooth transition of the lid-cheek junction, restore the horizontal length of the eyelid fissure, return the lower lid position to the correct anatomical location, and restore the position of the lateral canthal angle. Various surgical techniques and increasingly popular minimally invasive procedures are available for rejuvenation of the eyes, brows, and midface. The approach to periocular rejuvenation has shifted from removal and reduction in the past to lifting and volumization, matching our improving understanding of pathophysiology of the aging face.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

Consent for Publication Patients signed informed consent regarding publishing their data and photographs.

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