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Review

# Periorbital facial rejuvenation; applied anatomy and pre-operative assessment

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## Abstract

***Purpose***: Since different subspecialties are currently performing a variety of upper facial rejuvenation procedures, and the level of knowledge on the ocular and periocular anatomy and physiology is different, this review aims to highlight the most important preoperative examinations and tests with special attention to the eye and periocular adnexal structures for general ophthalmologist and specialties other than oculo-facial surgeons in order to inform them about the fine and important points that should be considered before surgery to have both cosmetic and functional improvement.

***Methods***: English literature review was performed using PubMed with the different keywords of "periorbital rejuvenation", "blepharoptosis", "eyebrow ptosis", "blepharoplasty", "eyelid examination", "facial assessment", and "lifting". Initial screening was performed by the senior author to include the most pertinent articles. The full text of the selected articles was reviewed, and some articles were added based upon the references of the initial articles. Included articles were then reviewed with special attention to the preoperative assessment of the periorbital facial rejuvenation procedures.

***Results***: There were 254 articles in the initial screening from which 84 articles were found to be mostly related to the topic of this review. The number finally increased to 112 articles after adding the pertinent references of the initial articles.

***Conclusion***: Static and dynamic aging changes of the periorbital area should be assessed as an eyelid-eyebrow unit paying more attention to the anthropometric landmarks. Assessing the facial asymmetry, performing comprehensive and detailed ocular examination, and asking about patients' expectation are three key elements in this regard. Furthermore, taking standard facial pictures, obtaining special consent form, and finally getting feedback are also indispensable tools toward a better outcome.



*Keywords:* Blepharoplasty; Cheek; Eyebrow; Eyelid; Lifting; Rejuvenation

## Introduction

The periorbital region of the face is an important anatomical area for any surgical and non-surgical rejuvenation procedures which includes different subunits in which the eyes are in the center (Fig. 1). Involutional changes of eyebrow and eyelid are divided into static and dynamic components. The static component is defined as reducing the global loss of volume due to changes in bone and fat pad that support the eyebrow.[1–5] On the other hand, the dynamic component refers to changes in resting muscle tone[6] and their interactions. In

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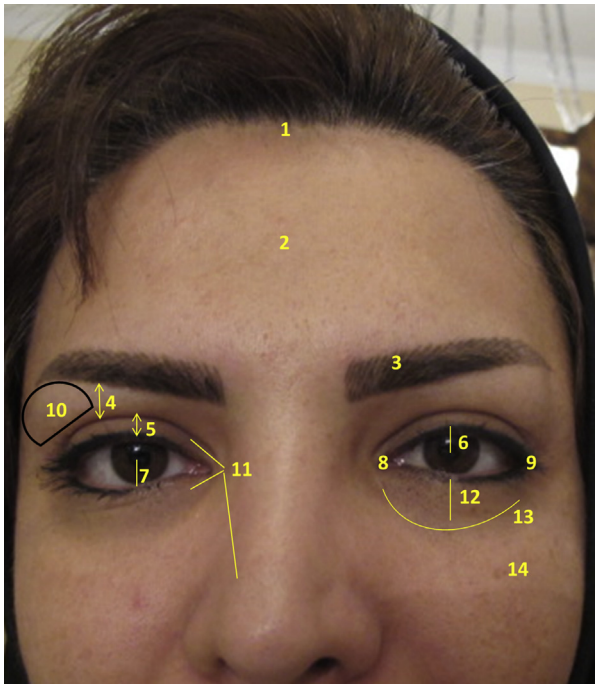


Fig. 1. Anatomical land marks in the periorbital region: 1. Hairline; 2. Forehead; 3. Eyebrow; 4. Brow fat span; 5. Tarsal plate show; 6. Margin reflex distance 1(MRD1); 7. Margin reflex distance 2; 8. Medial canthal angle; 9. Lateral canthal angle; 10. Lacrimal gland; 11. Lacrimal drainage system; 12. Lower eyelid height; 13. Inferior orbital rim and retaining ligament; 14. Cheek.

addition, skin changes are also contributed in aging process.[5,6] Although lateral eyebrow ptosis is one of the earliest manifestations of the facial droopiness by aging in the upper face,[7,8] it does not occur in isolation and often accompanies with dermatochalasis and upper eyelid ptosis. Dermatochalasis is skin redundancy of the upper eyelids hanging on or even beyond the eyelashes, mostly caused by aging.[9,10] Brow ptosis and dermatochalasis are two main causes of lateral hooding that can progressively obstruct the superolateral visual field,[11,12] resulting not only in a tired and heavy appearance but also in difficulty in putting make-up on the upper eyelid.[13]

The aim of this literature review is to summarize applied surgical anatomy of the upper and mid-face and provide readers with comprehensive preoperative steps in assessment of patients who are going to have eyelid and eyebrow rejuvenation procedures.

## Methods

English literature review was performed using PubMed with different keywords of "periorbital rejuvenation", "blepharoptosis", "eyebrow ptosis", "blepharoplasty", "eyelid examination", "facial assessment", and "lifting". Initial screening was performed by the senior author to include the most pertinent articles with regard to the preoperative assessment of periorbital rejuvenation procedures. The full text of the selected articles was reviewed, and some articles were added based upon the references of the initial articles. Included articles were then reviewed with special attention to the preoperative assessment of the periorbital facial rejuvenation procedures.

## Results

There were 254 articles in the initial screening from which 84 articles were found to be mostly related to the topic of this review. The number finally increased to 112 articles after adding the pertinent references of the initial articles. Included articles for this review were 3 case reports,[14–16] 1 discussion,[17] 1 book chapter,[18] 1 guideline,[19] 26 review articles,[2–6,10,13,20–38] 30 observational studies,[1,7,8,39–65] 36 retrospective case series,[9,13,66–99] 12 prospective case series,[11,12,100–109] 1 clinical trial,[110] and 1 systematic review.[111] The results are divided into 3 main sections of applied surgical anatomy of upper and mid-face regions, the main concern of eyebrow and eyelid ptosis, and 15 key preoperative examinations and tests.

### *Applied surgical anatomy*

#### *Bones and muscles*

The bony anatomy of the brow and forehead is defined by the supraorbital rims and the frontal bone of the skull. The supraorbital rim is more prominent in men than in women, creating a more masculine, angular appearance to the brow. The male forehead is more vertically oriented than the female forehead.[20] Periorbital muscles are divided into eyebrow elevator (frontalis) and depressor (corrugator, orbital portion of orbicularis oculi, depressors supercilii, and procerus).[6,39] Frontalis muscle (forehead) is enveloped by the galea aponeurotica and acts as a main elevator of the eyebrow and makes transverse forehead wrinkles.[66] Galea also plays a role in raising the eyebrows and glabella. Orbicularis oculi muscle is a sphincter around the bony orbit and responsible for the eyelid closure[21] in which medial and lateral portions depress the eyebrow correspondingly.[22] The corrugator supercilii muscle originates from the supraorbital ridge of the frontal bone, extends superolaterally, draws the eyebrow medially, and forms vertical nasoglabellar wrinkles.[20,40,66] Procerus muscle originates from lateral nasal bone and extends superolaterally, whose contraction pulls the eyebrow inferiorly,[20] elevates the root of the nose, and forms the horizontal furrows of the frontonasal area.[66]

#### *Eyebrows*

The eyebrow is made up of a head, body, and tail. The horizontal length of the brows can measure 5.0–5.5 cm with a width of 1.3–1.5 cm.[10] It generally has an upward contour at the head and a downward contour at the tail.[5] The medial brow should begin at the supraorbital rim and laterally, end at an oblique line extending from the alar base through the lateral canthus (Fig. 2).[41] The highest peak of the brow should be at the junction of the middle and lateral third.[23,41,67] An eyebrow extending above the orbital rim is a sign of beauty,[24] but a lower brow position is less aesthetically desirable.[100] The topography of the brow and upper eyelid vary according to gender, age, and ethnicity.[21,42–44]

The ideal female eyebrow has been described as resembling the wing of a gull.[21] In women, the eyebrow is positioned


Fig. 2. The medial brow is at the imaginary line drawn perpendicular to the alar base (Line 1), lateral brow terminates at an oblique line extending from the alar base through the lateral canthus (Line 2), and both ends are at the same horizontal level (Line 3).

0.5−1 mm[23] above the orbital rim and is arched, with its apex between the lateral limbus and lateral canthus, 3 mm above the orbital rim (Fig. 3, left).[13] The most lateral portion of the female eyebrow (the "tail") lies on a horizontal plane that is 1−2 mm above the lowest portion of the medial eyebrow.[21] The youthful male brow is flatter and fuller, and runs over the orbital rim without peaking and arching that is evident in women (Fig. 3, right).[20,41,68]

Asians have some specific anatomical characteristics such as thicker eyelid skin, higher position of the eyebrows, wider upper eyelids,[44] and variable presence of an eyelid crease (usually lower in the range of 2−5 mm from the eyelid margin) and absent in approximately 50% of Asians), that should be considered in the surgical approach (Fig. 4).[4,5,45,46,68,69,110] They also have more pretarsal fat and

Fig. 3. Female eyebrow is positioned above the orbital rim (line) and is arched with its apex between the lateral limbus and lateral canthus (arrow) (Left). Male brow is flatter and fuller which runs over the orbital rim (line) without the peak (Right).

Fig. 4. Asians have higher position of the eyebrows, wider upper eyelids, no or low crease, and different degrees of Epicanthal fold.

suborbicularis fat, which project inferiorly and tend to make their eyes puffy.[5,47]

Over time, the eyebrow tends to lose its lateral arch, and it appears somewhat flattened in older patients (Fig. 5, left).[21] Some studies show paradoxical elevation of the brow with age[48,49] in particular in medial and mid brow.[21,48,49] But it can descend or remain stable in others.[10,50] One of explanations for brow elevation is chronic activation of the frontalis muscle with associated elevation of the brow-eyelid complex to overcome clinical or subclinical levator system weakness and upper visual field defect due to redundant upper lid skin (Fig. 5, right).[70,71] However, because of the absence of the frontalis muscle extension in the lateral brow[8] and slackening of the lateral ligament, the senescent ptosis of the brow are more severe and occur earlier in the lateral versus medial brow.[72]

*Eyelids*

Eyelid structure consists of three layers. A thin skin layer is the outer layer overlying the tarsus and preseptal areas. Eyelid skin is the thinnest of all body skin and has no subcutaneous fat. Eye brow skin is thicker. The middle layer includes the orbital septum and orbicularis oculi muscle.[6] Orbicularis muscle with overlying skin and fat pad are represented as the "lid fold" that cover the lid crease in primary position of the eye.[6] Orbital septum is a connective tissue sheet that extends toward the bony orbit. It inserts also onto the levator aponeurosis which then sends projections to the eyelid skin and orbicularis muscle to create the upper eyelid crease. These attachments prevent the descent of the orbital fat and project tissue anteriorly as the eyelid fold above the crease.[6] The second eyelid elevator with an autonomically innervation is called the Muller muscle which arises from the undersurface of the levator muscle and inserts onto the superior border of the tarsus.[4] Tarsal plate and palpebral conjunctiva provide a frictionless surface known as the inner layer of the eyelid.

*Ligaments, fascia, and tendons*

Whitnall ligament is a suspensory ligament, preventing excessive posterior movement of levator muscle. The capsulopalpebral fascia is the lower lid analog to the levator aponeurosis. It arises from fascia of the inferior rectus muscle, and after surrounding the inferior oblique muscle, forms Lockwood's suspensory ligament that corresponds to the Whitnall ligament in the upper eyelid.[51] Lateral orbital thickening is a triangular condensation of the superficial and deep fasciae crosses the frontal process of the zygoma onto the deep temporal fascia. Orbital retaining ligament (Fig. 6) spans from the periosteum of the inferior orbital rim to the fascia on the undersurface of the orbicularis muscle. The periosteal attachment continues around the inferior orbital rim until merging with lateral orbital thickening immediately below the lateral canthal region. In this region, the retaining ligament is thicker and less distensible. The orbicularis retaining ligament is a bilaminar membrane enveloping a layer of fat which determines the thickness of the ligament. Zygomaticofacial nerve is a reliable surgical landmark for the location of the retaining ligament.[52] Considering the orbicularis retaining ligament's functions as 1) a fixation point for the orbicularis muscle of the upper and lower eyelids and 2) protective structure for the ocular globe is beneficial for surgeons to avoid ocular complications and reach better results in brow-lift procedures.[53] The retaining ligament, orbital thickening, and lateral palpebral raphe form an anatomic unit. Moreover, this unit is connected to the deep head of the lateral canthal tendon

Fig. 5. Aged brow is flatter and laterally dropped (Left). However, associated blepharoptosis may cause compensatory eyebrow elevation (Right) in both old and young patients.

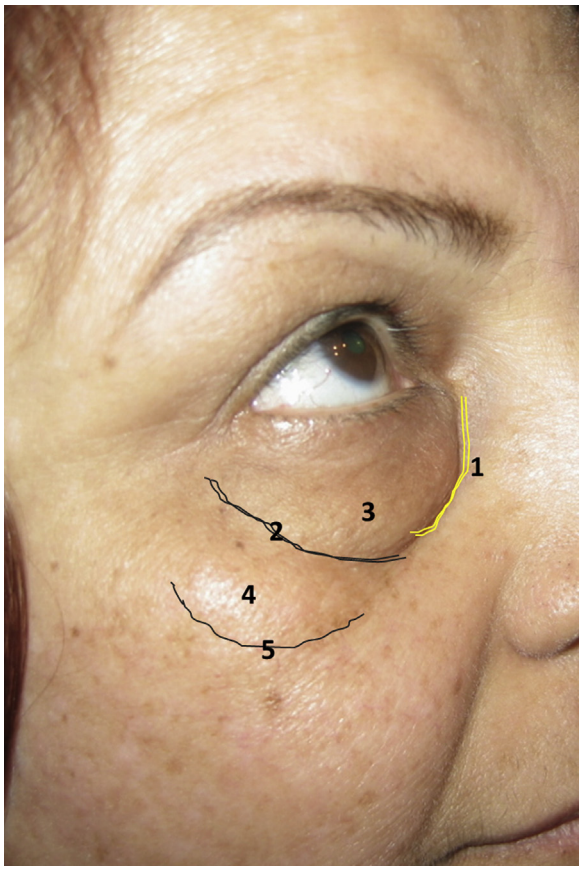


Fig. 6. Tear trough ligament (1) and orbital retaining ligament (2) separate the protruded orbital fats (3) from the cheek. Malar bag (4) presents above the zygomatic cutaneous ligament (5).

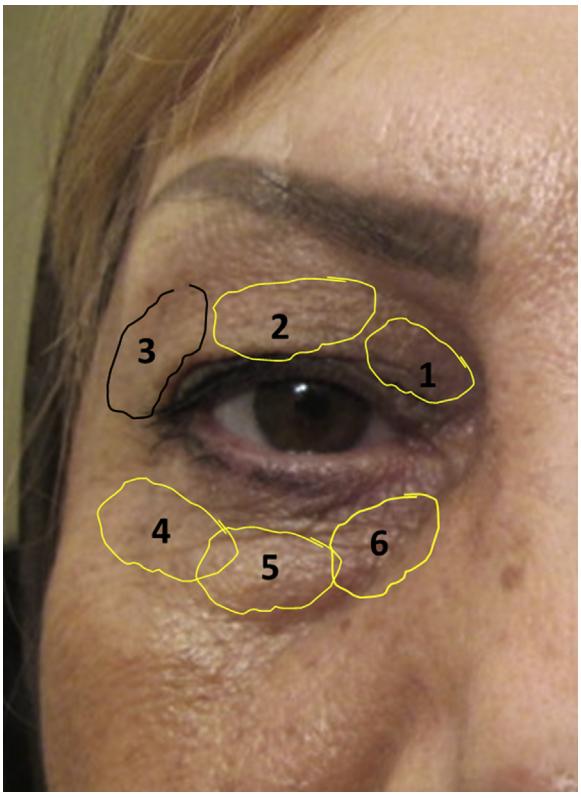


Fig. 7. Medial (1) and preaponeurotic (2) fat pockets are present in the upper eyelid. Lacrimal gland (3) is located in the upper lateral part in the same anatomical plane as preaponeurotic fat pocket. Lower eyelid includes lateral (4), central (5), and medial (6) fat pockets.

by the orbicularis fascia on the deep surface of the orbicularis oculi muscle and its fascial connections to the tarsal plate.[52]

Tear trough is a true osteocutaneous ligament commences medially, at the level of the insertion of the medial canthal tendon, to approximately the medial-pupil line, where it continues laterally as the orbicularis retaining ligament (Fig. 6).[54]

*Fat pockets*

There are three main fat pads in the periorbital area including preaponeurotic fat pad, preseptal fat pad, and galea fat pad or retro-orbicularis oculi fat (ROOF) pad. Preaponeurotic fat pad is located posterior to the orbital septum and separated from preseptal fat pad by the septum and from the deep orbit by the levator aponeurosis.[6,8] The galea fat pad or ROOF is located under the brow skin in the cover sheet of the deep galea.[8] Galea fat pad is more prominent laterally and usually displaced inferior and anterior to the orbital septum by aging which may be confused with the preaponeurotic fat pad.[25,48] Descending of the preseptal and the galea fat pads may facilitate gravitational descent of the unsupported lateral eyebrow that produces more tension on the orbital ligament and deep galea, causing temporal eyelid fullness and further restriction of the frontalis muscle.[73] Inferiorly, there are 3 pockets of orbital fat (medial, central and lateral) which separated from the malar fat by the mean of orbital retaining ligament (Fig. 7). Similar to ROOF, there is a suborbicularis oculi fat (SOOF) on the eyelid-cheek region.

*Motor and sensory nerves*

Facial nerve is innervating all the periorbital muscles (Fig. 8). Frontalis branch of facial nerve gives lies deep to the frontalis muscle along with the superficial temporal vessels.[25,26] Pretarsal and preseptal parts of orbicularis oculi muscle are innervated by zygomatic branches of the facial nerve that approached the muscle at a right angle. Buccal branches also participate in innervation of the medial portion of the lower orbicularis oculi muscle.[27]

Sensory innervation of the medial eyebrow is provided by two branches of the ophthalmic nerve (V1) including supraorbital and supratrochlear nerves.[26] Lateral aspect of the eyebrow and forehead derive innervation from lacrimal (V1), zygomaticofacial (V2), and zygomaticotemporal (V3) nerves.[74] Blood supply of the upper face is provided by terminal branches of internal and external carotid arteries. External carotid artery gives rise to the superficial temporal artery which bifurcates into frontal and parietal branches above the zygomatic arch to nourish the lateral forehead. Terminal branches of the frontal artery anastomose with the supraorbital and supratrochlear arteries, both branches of the ophthalmic artery, the first branch of the internal carotid artery that supply the medial forehead.[26,40,74]

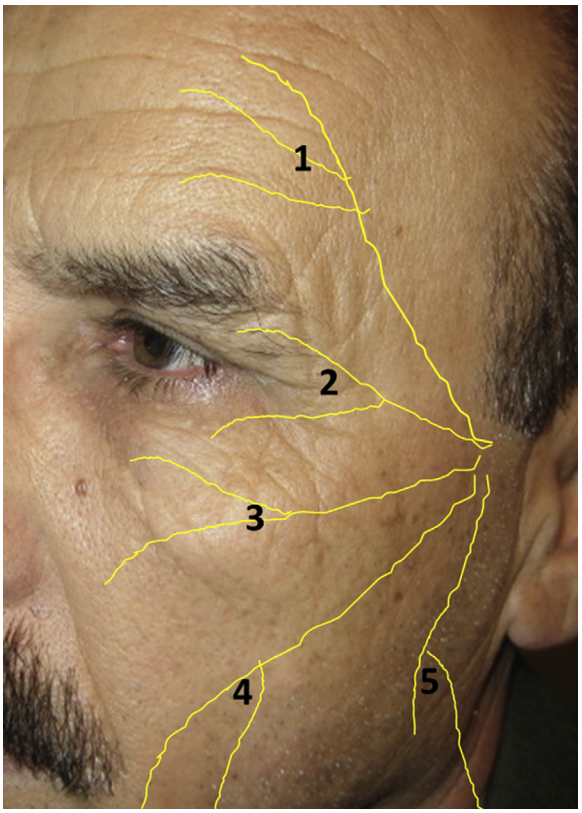


Fig. 8. Facial nerve gives rise 5 branches to different facial muscles which include frontal (temporal) (1), zygomatic (2), buccal (3), mandibular (4), and cervical (5).

*Main concern: eyebrow and eyelid ptosis*

Many patients presenting for upper blepharoplasty have a component of eyebrow ptosis[12,73,75,76] that can accentuate the upper eyelid abnormalities and compromise results of upper eyelid surgery.[1,12,70,100] Furthermore, blepharoplasty and eyelid ptosis repair performed in the presence of significant brow ptosis will pull the brow inferiorly which in turn recruits skin into the area beneath the orbital rim and reduce frontalis muscle elevation of the brow based on Hering's low.[10] This consequently results in further lowering of brow position.[1,5,8] Therefore a combination of eyebrow lift and blepharoplasty is sometimes necessary to achieve the desired results.[12,28,29,42,72,76,100] In general, eyebrow and eyelid should be considered as a "brow-lid continuum"[10] to obtain harmonious rejuvenation of the upper third of the face.[10,30] However, some patients have reported a good satisfaction after upper blepharoplasty in spite of simultaneous eyebrow ptosis.[55,77,100]

Real amount of eyebrow ptosis is determined at rest and in rest position of eyebrow with closed eye and no contraction of frontalis and glabellar muscles.[20,101] Eyebrow ptosis can be defined as an eyebrow that either falls below the superior orbital rim or extends less than 10 mm above the eyelid margin (Fig. 9, left). In other words, eyebrow ptosis should be considered when the upper lid height (ULH) is much less than 10 mm.[78] Eyebrow ptosis in men (Fig. 9, right) exists when the distance from the mid-pupil to the top of the brow is less than 2.5 cm.[20]

Upper eyelid ptosis (blepharoptosis) (Fig. 10) is evaluated by measuring either eyelid fissure height (EFH) or margin reflex distance 1 (MRD1). Measurement of the MRD1 allows more accurate assessment of the upper eyelid ptosis than measurement of EFH, as the MRD1 is independent of lower eyelid position.[21] Measurements with value of smaller than the lowest normal limit can signify upper eyelid ptosis.[21,56,102]

Acquired eyelid ptosis can be distinguished from congenital one by marginal crease distance (MCD). Most patients with dehiscence of the levator aponeurosis present with higher than normal crease whereas most patients with myogenic ptosis show no crease especially with a lower level of the levator function.

In addition, the upper lid sulcus height (ULSH) can be useful in the differentiation of the origin of skin laxity or eyelid ptosis. A low ULSH could be a sign of eyebrow ptosis (Table 1).[102]

*Fifteen key preoperative assessments*

It seems essential to follow a uniform format of measurements and examination in order to not only have a good plan for the upcoming procedures but also to have the postoperative

Fig. 9. Eyebrow ptosis in females (left) and males (right).

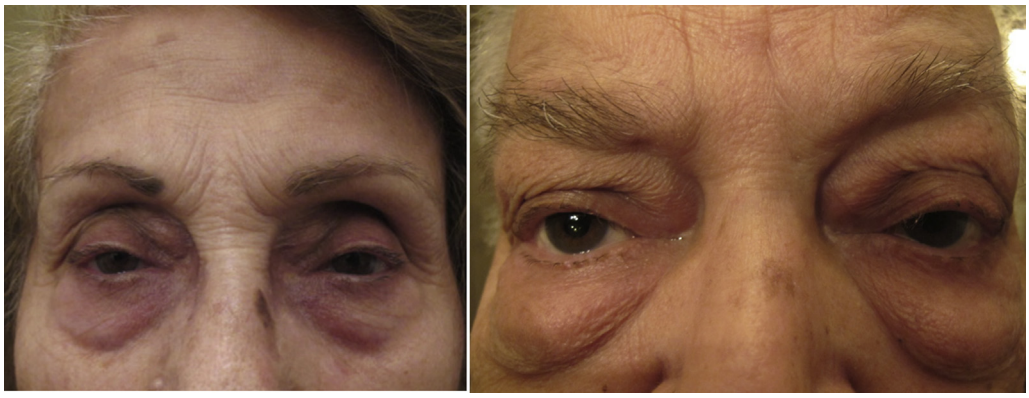

Fig. 10. While bilateral blepharoptosis may induce bilateral compensatory eyebrow elevation (left photo), unilateral blepharoptosis is associated with corresponding unilateral brow elevation (left eyebrow elevation on the right photo).

results comparable to each other. Therefore, an examination sheet would be very useful in the clinic to which one sample is shown in Fig. 11.

*History*

All the systemic disease and medications including herbal, over-the-counter, and supplemental medications should be recorded prior to proceeding with the plan of rejuvenation.[4,5] Thyroid dysfunction is one of the most important systemic diseases which should be considered before blepharoplasty. Patients with thyroid eye disease (TED) should show evidence of disease quiescence over a period of at least 6−9 months before offering rehabilitative surgical procedures.[31] In addition to systemic diseases, any history of laser-assisted in situ keratomileusis or refractive surgery should be elicited and blepharoplasty delayed until 6 months after refractive surgery

Table 1
Anthropometric landmarks for periorbital procedures.

| Anthropometric landmark | Definition |
|---|---|
| Palpebral fissure height | Vertical distance from the margin of the upper lid to the lower lid in primary position in a line passing the pupil[22,27,55] normal value: 10 mm |
| Eye fissure width | Distance between the medial canthus and the lateral canthus[27] |
| Eye fissure index | Representing the eye fissure height as percentage of the eye fissure width[35] |
| Tarsal Plate Show | Vertical segment between the eyelid crease and the upper eyelid margin in a line passing the pupil[35,55] |
| Brow Fat Span | Distance between the upper eyelid crease and inferior eyebrow[27,55] |
| Lower Eyelid Height | Vertical distance from the lower lid margin to orbitale inferioris (orbitale inferioris is defined as the point at which the lower eyelid meets the fascial profile)[55] |
| Canthal tilt | The angle between a horizontal reference line passing through the medial canthus and the eye fissure width[14] |
| The wrinkles of the upper eyelid | The absolute number of wrinkles was determined separately in each upper eyelid by counting the number of horizontal wrinkles[27] |
| Medial brow height (MBH) | Vertical distance between medial canthus to the inferior eyebrow cilia[22,55,79,86] or superior[a] eyebrow cilia[11,70,100,106] or middle brow cilia[5] |
| Lateral brow height (LBH) | Vertical distance between lateral canthus to the inferior eyebrow cilia[22,33,55,79,86] or superior[a] eyebrow cilia[11,70,100,106] or middle brow cilia[5] |
| Central brow height (CBH) | Vertical distances between the upper eyelid margin and inferior eyebrow cilia directly above the pupillary light reflex[22,79,86] or superior[a] eyebrow cilia[70,100,106] or middle brow cilia[5] |
| MRD1 | Vertical distance between central upper eyelid margin to the corneal light reflex[22,70,86,100] normal value: 4.0−4.5 mm |
| MRD2 | Vertical distance between central lower eyelid margin to the corneal light reflex[22,70,86,100] |
| Dermatochalasis reflex distance | Vertical distance between the lowest point of dermatochalasis to the corneal light reflex[86] |
| Marginal crease distance (MCD) | Vertical distance from the central portion of upper eyelid margin to the first skin fold of the upper eyelid in downward gaze[22,100]<br>normal value in men: 5−7 mm normal value in women: 8−10 mm |
| Margin to fold distance | Vertical distance from the central portion of upper eyelid margin to the first skin fold of the upper eyelid in primary position[5] |
| Brow elevation ratio | An intercanthal line that crosses the medial canthi is plotted on each photograph, and a vertical line perpendicular to this intercanthal line that is tangential to the lateral limbus is then drawn for each eye. Brow elevation ratio is the vertical height to the superior border of the brow divided by the horizontal distance[11] |
| Eyelid levator function | The excursion of the upper eyelid margin from downgaze to upgaze with the frontalis muscle immobilized.[101] Normal value: 12−16 mm |

MRD1: Marginal reflex distance 1.
MRD2: Marginal reflex distance 2.
[a] The top of the brow was chosen instead of the inferior because when women pluck their eyebrows they usually do not pluck them from the top, which gives this a more accurate fixed point.

**Upper /Mid Face Surgery Examination Sheet**

**Name : ……Age: ….. Chart No:…… Date: ……..□Married □Single**
**□Gel…… □BTA……□ Facial surgery: ……**
**□Trauma□Surgery□Thyroid dis. □Psychosocial……**
**Medication: □ ASA □ NSAID □ Warfarine □ Others ……**

| | | |
|---|---|---|
| Ocular Motility | | |
| Eyebrow position |  |  |
| Eyebrow Tattoo (total-lateral) | | |
| Sup.Brow –Pretrichial (mm) | | |
| Sup.Brow – L. Limbus (mm) | | |
| Lacrimal gland prolapse(1-3+) | | |
| Lateral hooding (1-3+) | | |
| Dermatochalasis (1-3+) | | |
| Upper medial fat (1-3+) | | |
| MRD1 (mm) | | |
| MRD2 (mm) | | |
| Levator function (mm) | | |
| Crease (mm) | | |
| Frown lines (1-3+) | | |
| Forehead crease | | |
| Crows' feet (1-3+) | | |
| Lower fat pads (1-3+) | | |
| Tear trough (1-3+) | | |
| Lower lid laxity | | |
| Corneal sensation | | |
| Dry eye | | |
| Bell's | | |

Fig. 11. Authors' proposed examination sheet for the patients who request periorbital facial rejuvenation procedures.

in order to avoid ocular surface damage.[23] Previous brow or lid surgery should also be asked,[5] and a conservative approach must be taken in any unsatisfied patient who has a history of prior blepharoplasty or brow surgery to prevent exacerbation of the condition.[20]

*Expectations*

Prior to surgery it is important to ask about the patient's expectation from the surgery.[4,21,32,41,79] Some discrepancies may exist between patients' real problem and their will. The surgeon should discuss the problem of facial asymmetry with the patients[18,76] who are mostly not aware of it because the asymmetry is subtle.[9,18,80] It is also suggested that the surgeon shows the probable result of the surgery and postoperative shape of the eyebrow to the patient in preoperative phase as much as possible.[101] A mirror can help the surgeon and patient have a better understanding of each other's concern. This will allow for a comprehensive surgical plan and help ensure reasonable patient expectations.[21,81]

*Eye examination*

Appropriate examination of the vision (visual acuity and sometimes visual field) and ocular motility (occult diplopia, phoria, and tropia) are important to detect other issues that can affect the result of periorbital rejuvenation procedures.[4,5,82,103]

*Tear production and lacrimal drainage assessment*

Dry eye syndrome (DES) is a common condition that is seen with increased prevalence in postmenopausal women and elderly[33] who are also the main target groups for facial

rejuvenation procedures. Patients with preoperative history of DES may be at greater risk for developing dry eyes or chemosis following surgery.[83] Therefore, comprehensive ocular examination for detecting DES in preoperative phase is important to reduce postoperative complications.[103] Measuring the amount of tear production by the Schirmer's test,[57,84] tear break up time, ocular surface staining, and tear meniscus height will highlight any associated ocular surface abnormalities.[85] Other signs which suggest an increased risk of postoperative ocular surface problems are scleral show, lagophthalmos, negative vector, positive snap back test, previous eyelid surgery, and increased blinking rate.[58]

Eyelid laxity or malposition can be associated with tear drainage system malfunction which leads to epiphora.[86,87] Slit-lamp examination should be performed for recognizing any abnormalities of the eyelids, especially the medial aspect, for malpositions (entropion, ectropion), punctual stenosis, and position of conjunctiva and caruncle with respect to the punctum. Dye disappearance test (DDT), regurgitation test, and irrigation of the lacrimal system may be performed to assess the lacrimal drainage system.[34] Facial paralysis should also be considered in patients with asymmetric face who complain of tearing.[73] A Hertel exophthalmometer can be used to measure eye prominence preoperatively. Patients with prominent eyes (>18 mm) may be predisposed to lid malposition, scleral show, or dry eyes postoperatively.[5,23]

*Eyelid examination*

Evaluation of lateral canthal support and eyelid tone and position are essential part of facial rejuvenation procedures especially on the lower eyelid.[104] The position of the lateral canthus relative to the medial canthus, or canthal tilt should be noted. The finger suspension and elevation test is used to determine the proposed effect of lateral canthal anchoring and spacer placement, respectively.[17] The snap-back test is used to assess the eyelid laxity in which lower lid is pulled down and away from the orbit and time taken for the eyelid to return to normal position is noted. The longer the duration, the more lax is the lower eyelid. Digital subtraction test is another test which measures horizontal laxity by recording the distance between the globe and the lower eyelid margin when pulled anteriorly with the eye in primary position. Forniceal preaponeurotic fat prolapse was assessed by pulling the lower lid margin to the level of the inferior orbital rim and comparing the meniscus of protruding fat in each fornix.[59]

*Lateral hooding and eyebrow fullness*

Lateral hooding is an excess lateral upper eyelid skin where there are always some degrees of lateral eyebrow ptosis (Fig. 12, left). It can be assessed and then addressed either by lateral eyebrow lifting or tailoring the upper blepharoplasty incisions to include the hooding.[88] It sometimes raises a red flag for a prolapsed lacrimal gland (Fig. 12, right).

Heavy eyebrow due to prominent ROOF could be observed because of family background, TED, and or previous gel or fat injections.[60] Simultaneous debulking of such heavy ROOF may result in a better tarsal plate show and eyebrow contour, even though overzealous removal of fat is as unpleasant as upper eyelid preaponeurotic fat removal.[89,105,110]

*Lacrimal gland prolapse*

Lacrimal gland prolapse appears to be a normal involutional periorbital aging change caused mainly by relaxation of the local suspending ligaments.[106] Most cases are moderate in degree, and not associated with specific preoperative symptoms or complaints, except lateral hooding (Fig. 12, right).[106] Therefore, there should be a preoperative clinical suspicion of lacrimal gland prolapse for patients with bulging lateral thirds of the upper eyelids. In cases of frank preoperative prolapsed lacrimal gland, a blepharoplasty and repositioning of the lacrimal gland should be performed.[14,35] Blepharoplasty in patients with an undetected partially prolapsed lacrimal gland

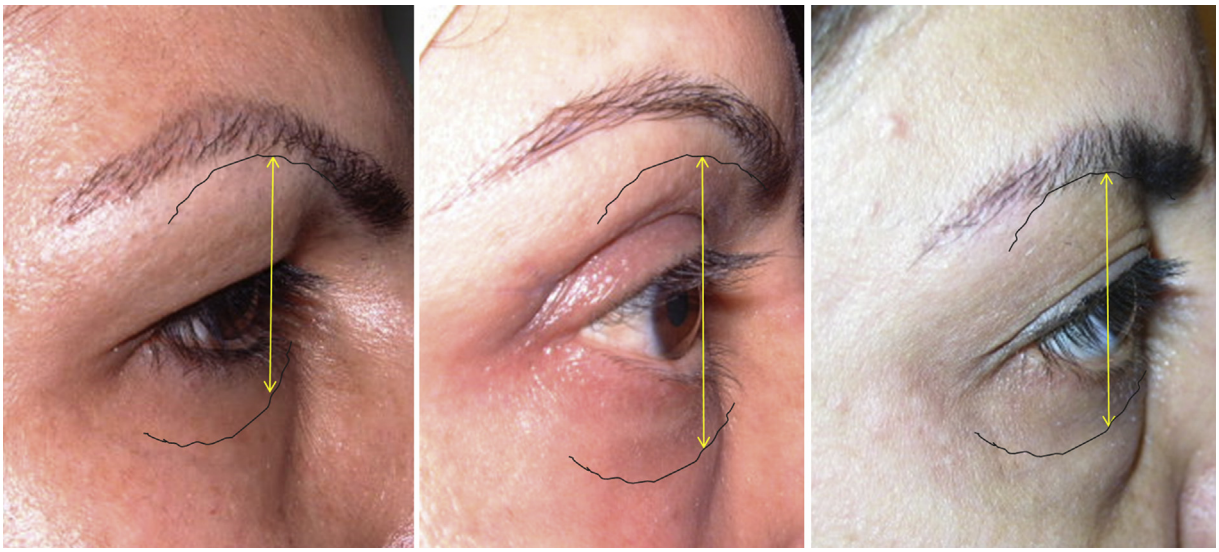

Fig. 12. The two most common causes of lateral hooding are lateral eyebrow ptosis (left, arrows) and lacrimal gland prolapse (right, arrow).

Fig. 13. Eyelid-globe vector assessment. In the lateral view, a line dropped from the supraorbital rim to the infraorbital rim. Positive vector is when the cornea is posterior to this line (left), neutral vector is when they touch (middle), and negative vector is when the corneal apex is anterior to the line (right).

can result in the formation of fistula and lateral hooding after blepharoplasty.[15]

*Eyelid-globe vector assessment*

A vector is drawn to detail the relationship of the globe to the most anterior aspect of the maxillary prominence. This relationship is best assessed by evaluating the patient in a lateral view. In the lateral view, a line dropped from the supraorbital rim to the infraorbital rim just touches the cornea. If the cornea is posterior to this line it is a positive vector, like an enophthalmos (Fig. 13, left). Neutral vector is when the line crosses the corneal apex (Fig. 13, middle). When the cornea is anterior to it than the eye is prominent and there is poor globe support, this is called negative vector[36] (Fig. 13, right). Negative vector indicates a higher likelihood of postoperative complication rate after blepharoplasty particularly lower eyelid malposition including ectropion.[90,91] In such cases the lateral canthal tightening should be performed to avoid the inferior scleral show and ectropion.[91]

*Facial symmetricity assessment*

Although eyebrow ptosis and blepharoptosis usually occur bilaterally, some degree of asymmetry often exists between the right and left side. The asymmetry is defined as more than one score difference in the degree of skin excess as and or more than 1 mm difference in palpebral fissure height.[9,21,61] The prevalence of asymmetry of the palpebral fissure in the Asian population is estimated at 30%.[21] In Caucasians, 93% of patients had greater than or equal to 1 mm of asymmetry in at least one of four measurements including medial brow height (MBH), central brow height (CBH), lateral brow height (LBH), and MRD1.[81] Involuntary asymmetric eyebrow ptosis is significantly associated with ocular dominancy[92] which should be included in evaluation of patients with asymmetric brow position.[92] Asymmetric face should be identified and mentioned preoperatively.[4,20] A clear understanding of the pathogenesis of the asymmetrically ptotic eyebrow is essential in the management of various forms of eyebrow asymmetry.[7] Different etiologies can be related to asymmetric eyebrows including trauma or previous surgery, facial palsy, family history and underlying skeletal asymmetry, eyelid retraction, and pseudo-proptosis.[16,37] However, unequal muscle action and upper eyelid ptosis are the most common causes (Fig. 14).[80] Management of eyebrow asymmetry attributable to compensatory eyelid ptosis differs from the treatment of other known asymmetries. Repair of the eyelid ptosis may eliminate the need for eyebrow procedure.[7]

*Hairline pattern*

Hairline pattern constitutes one of the chief challenges in male brow-lifting.[5,79,93] The surgeon must not only evaluate current hair pattern of the patient, but also predict the future hair pattern by asking about the history of the stability of the patient's hair pattern and assessing the current height and density of the frontal hairline and the extent of alopecia. The true evaluation can guide the surgeon to choose a surgical approach that is inconspicuous at the time of surgery and in the future. Patients with low and stable hairlines are good

Fig. 14. Asymmetric eyebrow ptosis and higher tarsal plate show on the left side point out the possibility of left upper blepharoptosis.

Fig. 15. While patients with lower hair line (left) are good candidates for endoscopic upper face lifting, other forehead and eyebrow procedures should be sought for patients with high hairline (right).

candidates for endoscopic upper face lift (Fig. 15, left). Pretrichial approach may be best suited for men who have elevated but stable hairlines, or for those considering hair restoration surgery (Fig. 15, right). Mid-brow techniques are most appropriate for those who have receding hairlines.[5,20] The direction of hair growth should also be assessed. Eyebrow hair growing superiorly is better served by a direct brow lift because the scar will be well camouflaged. Forehead hair growing inferiorly will better camouflage a pretrichial scar.[20]

*Skin texture*

Brow lift is more challenging in thick, oily skin types as compared with fair skin. Coarse skin types generally form less favorable scars than fine skin. Men generally demonstrate as those possible in fair, thin skin.[20]

*Frontalis muscle activity*

The frontalis muscle helps the levator palpebrae superioris muscle in severe redundancy of the ptotic upper eyelid skin for lifting the upper eyelid.[20] Eyebrow ptosis elicits a compensatory frontalis muscle over activity and, consequently, eyebrow elevation.[7] When the frontalis is put at rest by the examiner's finger, with gentle pressure downwards to eliminate the forehead rhytides, these patients manifest significant eyebrow ptosis.[10] This frontalis compensation is more significant in patients with blepharoptosis (Fig. 14).[1,6,11,81] Although there is controversy about eyebrow position after blepharoplasty in patients with preoperative activation of frontalis musculature,[29,100,101,107] the evaluation of its activity according to wrinkling appearance and horizontal lines of forehead is essential before surgery to choose best surgical approach.[101] It is also important that the frontalis muscle

Fig. 16. Proposed preoperative photography for patients with periorbital facial rejuvenation: primary gaze, up gaze, down gaze, and two oblique profile photos.

should be relaxed during the preoperative measurement procedure.[101]

*Tattoo*

Having a tattoo in the eyebrow or planning one in the future can affect our surgical approach in blepharoplasty and should be asked in preoperative evaluation.[101,108,109] The direction of eyelid margin tattoo is also important for upper blepharoplasty marking.

*Photographs*

Photographic documentation is a part of the patient's medical record in a plastic surgery practice.[5] This important step helps in preoperative planning and can also be used as a reference in the operating room. Photographic documentation further assists in reviewing procedural results with the patient postoperatively, and allows for critical review of surgical outcomes for the physician. It is necessary to equal the environmental factors during photographing like lighting condition, fixed distance between patient and camera, and the same photographer to reduce discrepancies between preoperative and postoperative photos that can confound the results.[72,94] Different software like "National Institute of Health (NIH) Image J software",[72,94] "Photoshop",[11] "United Imaging Marketwise program"[95] and "Adobe imaging software"[48] are used to digitally measure the anthropometric distances in photographs although sometimes researchers themselves do the analysis of photos.[62,81,96] Measurements in the patients' photographs should be standardized by different methods including white-to-white diameter as a conversion factor,[9,63,64,97] attachment of a ruler to the patient face as a reference,[11,48] the McCoy facial trisquare,[108] and a digital imaging system (Mirror Image, Fairfield, N.J.) containing a tool for analyzing distances.[98] Standardizing measurement makes all pre and postoperative photographs comparable. In the authors view, there should be 3 front photos (primary, up, and down gaze) to record the eyebrow and eyelid positions in different gazes and 2 lateral or oblique photos to mostly record the lateral eyebrow, lateral hooding, lacrimal gland prolapse, and eyelid-globe vector (Fig. 16). Additional photographs illustrating functional deficits, such as asymmetric lid height, may also be acquired.

*Psychological assessment*

Nearly half of the patients seek elective cosmetic surgery may have important psychiatric health issues such as body dysmorphic disorder, narcissistic personality disorder, or histrionic personality disorder.[65] Therefore, it is necessary to identify these subgroups of patients who especially have unreasonable motivations and expectations because despite clinically satisfactory outcomes, dissatisfied patients are at risk of experiencing further psychiatric problems such as depression, anxiety, social isolation, and self-destructive behavior.[38] Preoperative assessment tools can be useful in this issue.[111]

## Discussion

Volume loss of supportive structures, droopiness of the upper and mid-facial units, and imbalances of muscular interaction play the main role in formation of senile changes of the periorbital area. A comprehensive knowledge of applied surgical anatomy of upper and mid-face regions is essential in order to go through preoperative examinations and tests as well as ending up with satisfactory results. Preoperative assessment of this region must include all the examinations and tests with regard to the forehead, eyebrow, upper eyelid, lower eyelid, medial and lateral canthal angles, lacrimal glands, lacrimal drainage system, and especially the globe. Since most of the examinations and tests are in the field of ophthalmology, the best way of finding out any functional and or anatomical problem around the eye seems to be an ophthalmology consultation. Finally, a very detailed counseling and photographic documentation as well as psychological evaluation of the patients are important steps towards a successful surgical outcome.

## Summary points

- Volume loss of supportive structures, droopiness of the upper and mid-facial units, and imbalances of muscular interaction play the main role in formation of senile changes of the periorbital area.
- Periorbital rejuvenation procedures must be preoperatively assessed based on "brow-lid continuum" concept in which focusing on eyebrow or eyelid alone and overlooking the status of the other parts will lead to unacceptable results and dissatisfaction.
- While there is just one elevator muscle (frontalis muscle), multiple periorbital muscles act to depress the eyebrow.
- Displacing of ROOF, lateral brow ptosis, and lacrimal gland prolapse are the main factors for laterally more puffy and ptotic upper eyelids.
- Gender, ethnicity, and age are three main variables that affect eyebrow and eyelid topography.
- Upper margin reflex distance and EFH are two important anthropometric landmarks in detecting blepharoptosis.
- Discussing the goals of operation with the patient and modifying his or her expectation if it is away from reality, are critical steps before rejuvenation surgery that increase post-operation satisfaction of patient and surgeon.
- Taking photos is a common way for documentation. Analyzing anthropometric distances of these photos with software or manually.

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