Drooping of the upper eyelids is one of the most common complaints in oculoplastic practice. Other related complaints include difficulty seeing due to the attendant visual field obstruction and prefrontal headaches due to chronic use of the frontalis muscle in an attempt to lift the eyelids [1]. This anatomic and morphologic state is termed ptosis, from the Greek “to fall.”

Ptosis causes a simultaneous cosmetic deformity that is apparent both to the patient and to others. A recent study suggested that photographs of patients with droopy lids are subjectively perceived by others as less intelligent and more negatively than their counterparts when compared with photographs after having undergone ptosis correction [2].

Ptosis surgery can be challenging for even the most experienced eye and facial plastic surgeon. The rate of reoperation in most series of acquired ptosis varies from 5% to 35% [3–5]. The correction of ptosis of more complex etiology, and congenital ptosis may even be more elusive. To minimize reoperations and maximize postoperative symmetry, detailed preoperative assessment and intraoperative anatomic dissection with respect to tissue planes and hemostasis are necessary. This article discusses some of the more common types of ptosis and provides an introduction to the evaluation and management of the ptosis patient. Complications of ptosis surgery and recent innovations in ptosis surgery are discussed.

Terminology

The eyelid fissure is a measurement of the opening of the eyelid when the eye is in primary position (looking straight ahead). It is measured in millimeters at the center of the eyelid from the bottom of the upper lid to the top of the lower lid. The normal measurement is 9 to 10 mm. Ptotic eyes are defined as those with eyelid fissures less than 9 mm.
Marginal reflex distances (MRDs) are measurements that are often useful as well. MRD₁ is the distance from the upper eyelid to the corneal light reflex. Measurements less than 4 mm are considered abnormal; an MRD₁ of 2.5 or less is usually considered vision-impairing. MRD₂ the distance from the corneal light reflex to the lower eyelid. A normal measurement is 4 to 5 mm; a measurement of more than 5 mm represents a lower eyelid that is too low and can be caused by eyelid retraction or ectropion. A patient can have a ptotic upper eyelid and a normal eyelid fissure if the lower eyelid position is abnormally low. All three measurements are therefore important.

Levator function is a measurement of how well the levator muscle works. Normal function is greater than 11 mm. A measurement greater than 11 mm is considered very good, 8 to 10 mm is considered good, 5 to 7 mm is considered fair, and 4 mm or less is considered poor.

Classification of ptosis

Ptosis can occur for a variety of reasons. Congenital ptosis may be diagnosed shortly after birth. Mechanical ptosis due to dermatochalasis and brow ptosis is often seen in the aging population and can accompany many of the other types of ptosis. Myogenic ptosis, aponeurotic ptosis, neurogenic ptosis, and neuromyogenic ptosis (eg, ocular myasthenia) can all present in adults and present rarely in children as well [1]. The most common type of ptosis in adults is involutional ptosis secondary to acquired dehiscence or detachment of the levator aponeurosis from the tarsus [1,6]. Ptosis in children is most often myogenic in origin and due to levator muscle maldevelopment [1,6,7].

Myogenic ptosis

Myogenic ptosis occurs when levator strength has diminished [1]. The most common myogenic ptosis is simple congenital ptosis, which can occur as an autosomal dominant or, more often, sporadically [7]. Simple congenital ptosis is usually secondary to levator muscle maldevelopment. Approximately 30% of patients who have congenital ptosis will also have ocular motility disturbances, the most common being weakness of the ipsilateral superior rectus muscle [6–8]. Congenital myogenic ptosis is usually unilateral with no other associated facial abnormality (Fig. 1A) [7].

In acquired myogenic ptosis, levator function is usually moderate but may be normal early on in the course [1,6]. In congenital myopathic ptosis, lag on downgaze can be seen due to fibrosis of the levator, and lesser degrees of levator function are commonly seen.

Congenital ptosis can also accompany craniofacial syndromes. Most common among these are blepharophimosis syndrome and Marcus Gunn jaw wink syndrome [1,6,7]. Blepharophimosis can be inherited as an autosomal dominant trait. The signs of blepharophimosis are bilateral ptosis,
decreased horizontal fissure size, epicanthal folds (epicanthus inversus), telecanthus, and ectropion of the lower lateral eyelids (Fig. 1B) [7].

Marcus Gunn Jaw winking is caused by a miscommunication between the third cranial nerve that innervates the levator and the fifth cranial nerve that innervates the muscles of mastication. The result is a unilateral ptosis that resolves or improves when the patient opens the mouth or moves the lower jaw in a contralateral direction (Fig. 2A, B) [7]. Other less common craniofacial syndromes associated with a congenital ptosis are Turner’s syndrome, Noonan’s syndrome, Smith-Lemli-Opitz syndrome, Rubenstein-Taybi syndrome, Saethre-Chotzen syndrome, and

Fig. 1. (A) A 6-month-old patient showing congenital ptosis of the right upper eyelid. (B) A child with blepharophimosis. Note the ptosis, epicanthal folds, and telecanthus.

Fig. 2. A 5-year-old patient showing Marcus Gunn syndrome. Patient with ptosis of the right upper eyelid (A) that resolves with contraction of the ipsilateral masseter muscle (B).
fetal trimetadione [9,10]. Because of their rarity, these syndromes are beyond the scope of this article.

In adults, trauma can give rise to myopathic ptosis when the muscle itself is injured. More often, traumatic ptosis involves injury to the aponeurosis, the third cranial nerve supplying the levator muscle, or the bones adjacent to the levator (mechanical ptosis) impinging on the excursion of the muscle itself, or due to orbital injury with consequent enophthalmos [1,6]. Orbital roof fractures, in particular, often give rise to ptosis. If bony injury is suspected, the patient should be evaluated accordingly with appropriate neuroimaging studies. Edema of the eyelid after trauma can mimic ptosis; therefore, the diagnosis of a true ptosis may be delayed. Any lacerations of the eyelid involving the levator should be repaired as soon as possible unless the original injury is not found until weeks after the injury. At this time it is best to wait 3 to 6 months to see if there is any improvement in the ptosis before embarking upon surgical correction [6].

Patients may also present with myopathic ptosis following blepharoplasty surgery. This type of traumatic ptosis may be due to lid edema, hematoma, levator aponeurosis injury from cautery, or careless removal of the post septal fat from septal suturing, septal levator adhesions, or a blepharoplasty technique that involves supratarsal fixation [11,12]. Ptosis repair may be difficult, because the anatomy of the eyelid has been disrupted from the previous surgery. Mild ptosis may improve with time. Ptosis existing after 3 months should be repaired with the correct surgical procedure based on levator function [11].

Other types of myogenic ptosis seen in adults include oculopharyngeal dystrophy, chronic progressive external ophthalmoplegia (CPEO), myotonic dystrophy, and infiltrative ptosis [6]. Oculopharyngeal dystrophy is more commonly found in patients of French Canadian ancestry [7]. These patients have ptosis and also difficulty swallowing secondary to weakness of the oropharyngeal muscles. CPEO is inherited in 50% of patients, with signs and symptoms beginning in childhood [7]. CPEO results in ptosis and ophthalmoplegia and can be associated with retinal pigmentary problems and heart block. The classic presentation is a patient with ptosis and ophthalmoplegia without diplopia [6]. Most patient present with a bilateral, symmetric ptosis with decreased levator function [8]. The extraocular muscle become involved later in the course of the disease. Patients with ptosis and ophthalmoplegia of unknown etiology should have a cardiac workup including an electrocardiogram to rule out Kearns Sayre syndrome. Myotonic dystrophy has an autosomal dominant inheritance and is usually associated with ptosis, orbicularis weakness, and extraocular muscle weakness and may also be associated with cardiac conduction defects [13].

Myogenic ptosis can also be caused by infiltrative processes such as amyloidosis. Amyloidosis may affect other muscles, including the extraocular muscles, where it can be confused with orbital myositis [8]. Biopsies of the levator muscle or extraocular muscle can help establish the diagnosis.
The diagnosis can be made through the demonstration of birefringence and dichroism with Congo red stain [8]. Other stains including crystal violet and thioflavin-T may help with the diagnosis [8]. Treatment should include a systemic workup and referral to the appropriate specialist.

Biopsies of the levator muscle in congenital ptosis usually show an inversely proportional relationship between the amount of ptosis and the density of striated muscle [8,9].

The surgical correction of myopathic ptosis involves levator advancement surgery in patients with moderate to good function, or frontalis sling where levator function is more compromised. In general, the authors prefer autogenous slings in children above the age of 4, and favor giving adults the choice between adjustable silicone slings or autogenous slings based on the overall clinical situation.

**Aponeurotic ptosis**

The most common type of aponeurotic ptosis is involutional ptosis secondary to stretching, attenuation, or detachment of the levator aponeurosis from its tarsal attachments (Fig. 3) [1,6,7]. Examination of these patients usually reveal a normal levator function and a high eyelid crease [6,7]. The ptosis is normally bilateral and symmetric but may be unilateral and asymmetric. Patients with involutional aponeurotic ptosis should not have motility or pupillary abnormalities [1,6]. Stretching of the levator aponeurosis occurs commonly in patients who wear contact lenses and in patients who are constantly rubbing their eyes such as those with Down syndrome and in patients with ocular allergy [8].

Up to 6% of patients who have undergone cataract surgery can develop aponeurotic ptosis [8]. The mechanism of postcataract ptosis is thought to be trauma to the levator aponeurosis or the superior rectus muscle complex, which shares strong intermuscular fascial connections to the levator muscle and can be disrupted either by postcataract eyelid swelling or by the eyelid speculum used to separate the eyelids at the time of surgery [12].

The preferred surgical procedure in these patients is levator aponeurotic advancement.

Fig. 3. A 62-year-old patient showing bilateral dermatochalasis and aponeurotic ptosis.
Neurogenic ptosis

Neurogenic etiologies of ptosis include myasthenia gravis, III cranial nerve palsy, and Horner’s syndrome [7].

Myasthenic ptosis is due to a problem at the neuromuscular junction and therefore can be classified as neurogenic or myogenic (Fig. 4) [6,7]. Myasthenic ptosis is an autoimmune disease due to diminished acetylcholine receptors at the neuromuscular junction. It may be unilateral or bilateral and often involves the extraocular muscles. Ocular myasthenia is a form of myasthenia that only affects the extraocular muscles, the levator muscle or the orbicularis oculi muscle without systemic involvement [14]. The hallmark of myasthenia is the variability of the ptosis [6,7]. The ptosis usually worsens with fatigue and usually improves with the ice test or edrophonium test [1,7]. Other signs include ptosis that worsens in the evening, paradoxical eyelid retraction, and Cogan’s lid twitch, which is eyelid retraction that occurs after sustained downgaze.

Third-nerve palsies can be caused by tumors, vascular lesions, or inflammatory or neurotoxic diseases [7]. Palsies of the third cranial nerve present with ptosis, hypotropia, and extraocular motility disturbance that spare the lateral rectus and superior oblique muscle (Fig. 5A) [1,6]. Pupillary involvement resulting in a mydriatic pupil is seen with aneurysms of the posterior communicating artery. Aberrant regeneration may occur in patients with third-nerve palsy and is a sign of etiologies other than those that are ischemic, such as hypertension or diabetes. Patients with aberrant regeneration should be suspected to have intracranial tumors until proved otherwise and require neuroimaging. Work-up for patients with third-nerve palsies depends on the patient’s age and whether or not the pupil is involved. If the pupil is involved, an aneurysm of the posterior communicating artery should be presumed until ruled out by neuroimaging [14]. An MRI/MRA should be performed. If the MRI/MRA is negative and aneurysm is

Fig. 4. A 54-year-old patient showing bilateral ptosis secondary to myasthenia gravis. The ptosis worsens with fatigue.
considered, emergent angiography should be performed (MRA is not always sensitive enough to exclude an aneurysm) [15].

In children under 10 years of age, the most common cause of third-nerve palsy is congenital third-nerve palsy, which is usually incomplete and associated with aberrant regeneration. Third-nerve palsy in children can also be caused by ophthalmoplegic migraine.

In adults under 50 years of age, all third-nerve palsies are evaluated with an MRI, erythrocyte sedimentation rate, serologic syphilis testing, Lyme titer, glucose, and antinuclear antibody to rule out vasculitis and infection [8]. A spinal tap to rule out infection, meningiomatosis, and metastatic disease may also be required. After the etiology has been discovered, the patient should be given 6 to 12 months for spontaneous recovery of the palsy.

Levator function in third cranial nerve palsies may be absent or almost normal [6]. The most common surgical procedure in third cranial nerve palsies is the frontalis sling, particularly when levator function is absent or severely reduced. Any strabismus problem should be repaired before eyelid surgery, because alteration of globe position may result in a change in eyelid position [8].

Horner’s syndrome is due to damage to the sympathetic supply to the orbit from tumors, aneurysms, or inflammations. It results in ptosis, anhidrosis, and miosis (Fig. 5B) [6]. Horner’s syndrome can be present at birth and can present with concomitant third-nerve palsy [1,7]. The ptosis is often of a minor nature, up to 2.5 mm, and levator function is normal. In addition to ptosis, anhidrosis, and miosis, patients who have congenital Horner’s syndrome may have heterochromia, in which the affected eye has a lighter-colored iris [8].

Fig. 5. (A) This 52-year-old patient has a left-sided third-nerve palsy. Note the ptosis and mydriatic pupil on the left side. (B) This 50-year-old female has left-sided congenital Horner’s syndrome. Note the left ptosis, miosis, and lighter-colored iris.
The workup for acquired Horner’s syndrome includes pharmacologic testing with cocaine and hydroxyamphetamine. Cocaine prevents reuptake of norepinephrine and can aid in the diagnosis of Horner’s syndrome. In a patient with ptosis and anisocoria due to Horner’s syndrome, the instillation of 5% or 10% cocaine hydrochloride into the eyes will cause a dilation of the mydriatic pupil and only mild dilation of the miotic pupil, therefore increasing the amount of pupil inequality. Hydroxyamphetamine 1% eye drops help determine the location of the lesion along the sympathetic pathway; these drops should be used at least 48 hours after the cocaine test. Miotic pupils from preganglionic lesions or central lesions will dilate normally or more than the normal pupil after instillation of hydroxyamphetamine. Miotic pupils from postganglionic lesions do not dilate at all. Hydroxyamphetamine drops do not help the localization of the lesion in infants [8]. Postganglionic lesions are usually caused by benign vascular headaches (such as cluster headaches) or carotid dissection, and thus it is important to determine the cause of postganglionic lesions. Preganglionic lesions can be from malignant metastases or lung apex tumors. A Horner’s syndrome acquired in infancy can be caused by neuroblastoma [8]. Because of the magnitude of the ptosis, the preferred surgical correction for patients with ptosis from Horner’s syndrome is either a mullerectomy or an external levator aponeurotic advancement [8].

Mechanical ptosis

Mechanical ptosis is most commonly due to excess skin that hangs over the eyelid margin and decreases the visual field [6,7]. It can also be secondary to masses or scars that physically weigh down the lid or obstruct free movement (Fig. 6) [1,6,7].

Surgery for these patients involves the removal of the underlying abnormality such as excess skin, mass, or scar. Residual ptosis can be corrected by levator aponeurosis advancement in patients with normal levator function [8].

Fig. 6. A 60-year-old patient with a mass of the medial left upper eyelid resulting in left-sided ptosis.
Pseudoptosis

Pseudoptosis is an eyelid that seems ptotic but is not [7]. Causes of pseudoptosis include hemifacial spasm, facial nerve palsy with aberrant regeneration, contralateral lid retraction contralateral proptosis, enophthalmos, anophthalmos with superior sulcus deformity, and lower eyelid ptosis (Fig. 7) [1,7]. Floppy eyelid syndrome usually occurs in obese men, and its etiology is unknown. The tarsus of the eyelid becomes lax, resulting in redundant and “floppy” eyelids. The flaccid eyelids are easily everted and may present as dermatochalasis or pseudoptosis [8].

Examination of the patient with ptosis

History

A patient who has ptosis usually complains of heaviness of the lids, headache from constant use of the frontalis muscle, difficulty reading, difficulty seeing the superior visual field, and looking tired [1,6,7]. The duration of ptosis is significant to the history. Congenital ptosis, of course, will present early in life, but it may not be perceived by the patient’s parents; thus in all patients with a long history of ptosis, old photographs may be useful in the determination of the duration of the ptosis. Acquired types of ptosis are predominantly chronic and slowly progressive. Acute onset ptosis, in contrast, can be associated with eye or eyelid infection, allergy, angioneurotic edema, and, when associated with hypotropia, can signal aneurysm of the posterior communicating artery [15].

Ptosis may occur following surgery or other types of trauma, and a thorough past surgical history is mandatory. As discussed, both previous eyelid surgery and intraocular surgery can cause aponeurotic ptosis. Surgical sympathectomy or endarterectomy can also give rise to Horner’s syndrome.

Patients should be asked if the amount of lid droopiness varies throughout the day. Ptosis that worsens toward the end of the day or with fatigue can represent myasthenia gravis [7]. Patients should be asked about double vision; diplopia can be seen in myopathic ptoses such as diplopia in myasthenia gravis, CPEO, and third-nerve palsy [6,7].

Fig. 7. A 28-year-old patient with left-sided pseudoptosis. He sustained an orbital floor and medial wall fracture resulting in enophthalmos of the left globe and pseudoptosis.
Patients should also be queried about other eye problems, especially dry eyes and contact lens use. History should include any history of smoking, allergies, anticoagulant use, herbal medicine use, vitamins, and prescription medicines. Past medical history should query for sleep apnea and floppy eyelid syndrome. Family history may be relevant if oculopharyngeal dystrophy is entertained as a diagnostic possibility.

**Examination**

When examining a patient who has ptosis, several important measurements must be made that are critical to management and have a direct impact on surgical planning. The examination of the ptotic patient should also involve the normal side, if there is one, because symmetry is the desired goal if surgery is indeed performed.

Lid height or palpebral fissure is the distance from the bottom of the upper eyelid margin to the top of the bottom eyelid margin taken at the center of the eyelid. A normal measurement ranges from 8 to 10 mm.

levator function is obtained by measuring the movement of the upper eyelid from down-gaze to up-gaze while stabilizing the eyebrow/frontalis muscle (Fig. 8A, B). Normal levator function is considered to be greater than 11 mm [7].

The eyelid crease is the measurement of the distance from the eyelid margin to the eyelid crease when the patient is looking down at a 45° angle. The normal crease measurement is 7 to 8 mm in males and 9 to 10 mm in females [1,6].

MRD$_1$ should be measured and is particularly helpful if lower eyelid position is asymmetric (Fig. 9) [1,6].

![Fig. 8. Levator function is a measurement of the upper eyelid from up-gaze (A) to down-gaze (B).](http://www.ioi.com)
Determination of the patient’s dominant eye is valuable because levator muscle tone is influenced by ocular dominance in ptotic patients [16].

In the authors’ practice, most adult patients who have acquired ptosis are tested with neosynephrine to determine whether the ptosis diminishes following its instillation. After instilling a drop of 2.5% neosynephrine in the abnormal eye, the upper eyelid position is rechecked after 5 minutes. If the ptotic lid elevates by 2 to 3 mm, the patient may benefit from a tarsal-conjunctival resection or a conjunctival-Muller’s muscle resection surgery [13]. If external levator aponeurosis surgery is planned, determination of neosynephrine sensitivity allows one to plan for a greater intraoperative overcorrection, as the effects of neosynephrine in general mimic the effect of intraoperative epinephrine administered with the amide anesthetic.

In patients who are suspected of having a ptosis secondary to myasthenia, the ptosis should improve with the ice test and tensilon or the edrophonium test [1,7]. Applying an ice pack to the ptotic eyelid for 5 minutes should improve the ptosis in a patient who has myasthenic ptosis [13]. The tensilon test is performed by injecting 2 mg of tensilon IV to rule out an adverse reaction. This is followed by a second injection of 8 mg 30 seconds later. The ptotic eyelid should elevate within 1 to 5 minutes in a patient with myasthenic ptosis. In case of adverse reaction, it is recommended that injectable atropine be on hand to be administered intravenously [13]. A large percentage of patients who have myasthenia will also have acetylcholine receptor antibodies in their blood, which can be easily checked with a routine blood test [13]. Between 70% and 80% of patients with systemic myasthenia gravis will have autoantibodies to acetylcholine receptors. An electromyogram can also be performed in patients with suspected myasthenic ptosis and is the most specific study. Patients who have myasthenia will demonstrate a decreased amplitude of muscle action potentials [17].

Bell’s phenomenon must also be evaluated; this is the ability of the eyeball to move upward with eyelid closure. Orbicularis strength is tested by having the patient tightly close their eyes and resist the examiner’s efforts to open them.
The position of the lower eyelid is also important and should be noted. The lower eyelid may be higher than normal in patients who have Horner’s syndrome or may be lower than normal in patients with facial nerve palsy.

The amount of excess eyelid skin and fat and brow position are important preoperative parameters and should be recorded. Patients who have ptosis and excessive eyelid skin and fat may be better served with an anterior approach that enables the surgeon to address these problems simultaneously. Patients who have brow ptosis may benefit from a concurrent brow lift.

**Ancillary examination**

The patient should be examined for pupil abnormalities and motility problems. It is exceedingly important to assess the status of the cornea, as patients with drying of the cornea or instability of the precorneal tear film may have exacerbation of their symptoms following any type of ptosis procedure. Tests to rule out dry eye include Schirmer testing, as well as a slit lamp examination looking at the cornea and the precorneal tear film. Assessing corneal and conjunctival staining patterns with fluorescein, rose bengal, or lissamine green are also valuable adjuncts [8]. All patients with ptosis should be examined by an ophthalmologist before eyelid surgery.

**Documentation of ptosis before surgery**

In patients with ptosis, insurance companies usually require specific documentation before the surgery. Photographic documentation of the patient looking in primary gaze, down-gaze, up-gaze, and side views of the patient while looking in primary gaze all may be required and often are useful postoperatively to document the preoperative condition, because patients quickly forget the severity of their condition.

Visual fields of the patient illustrating defects in the superior visual field are usually also required. The visual field is performed on each ptotic eyelid with the eyelids in their natural position and again with the eyelids taped up to simulate the postsurgical response. Insurers usually require a difference of at least 12° between the two fields, but different states and different insurances vary in their requirements. Recent studies have demonstrated that manual kinetic visual field testing (Goldmann) and automated static visual fields (Humphrey) are equally effective at demonstrating ptosis. However, the automated static testing may be less sensitive and also has a longer examination time [18].

Interestingly, there is a rationale to the requirements of visual field to document field loss and severity of ptosis. A recent study has shown that the degree of ptosis is proportional to the superior field depression with both static and automated perimetry [19].
Surgical management

The most common procedure performed for all types of ptosis in our practice with few exceptions is levator advancement. This versatile procedure can be used on patients with all but the most severe impairment in levator function. At the time of ptosis surgery, we explore the levator muscle and aponeurosis to determine anatomic relationships and try to use existing anatomy to obtain more favorable eyelid position. The effectiveness of this approach can be verified at the time of surgery, and the adequacy of eyelid curve and contour can be ascertained simultaneously. External surgery also allows the surgeon to remove excess skin and fat which often improve the aesthetic outcome.

Levator advancement

This procedure is the most common technique of ptosis surgery in our practice [20]. For adults, monitored anesthesia is recommended to be able to adjust lid height with the patient’s cooperation. Patients with dry eyes are usually better served with a modest correction instead of a maximum correction.

Anesthetic eye drops are instilled in each eye. The patient’s natural eyelid crease is marked using a sterile marking pen and symmetry to the fellow eyelid crease is verified (Fig. 10A), after which 0.5 to 1.0 mL of local anesthetic is injected subcutaneously and allowed to diffuse using gentle massage. The patient is prepped and draped in the usual sterile manner. A skin incision is made in the marked eyelid crease site. The edges of the orbicularis are tented upward with two 0.5 tissue forceps (Fig. 10B). A skin muscle flap is dissected superiorly, exposing the point of fusion of the levator with the septum, and continued till preaponeurotic fat is visualized beneath the septum. This natural anatomic plane can be dissected either with a cautery, a scissors, or bluntly with a cotton tip. The septum over the pre-aponeurotic fat pad is incised with sharp Wescott and opened completely. The pre-aponeurotic fat is then swept off the aponeurosis gently. The superior tarsal border is exposed and the levator aponeurosis is then dissected off the superior aspect of the tarsus using Wescott scissors (Figs. 10C and 10D). The inferior edge of the aponeurosis is grasped and dissected off Muller’s muscle by moving the aponeurosis edge superiorly and inferiorly. A nonabsorbable suture such as 6-0 silk on a tapered or spatulated cutting needle is used to attach the levator aponeurosis to the superior tarsal border, creating an edge-to-edge reapproximation of the levator aponeurosis to the tarsal leading edge (Figs. 10E and 10F). The knot is secured with a slip knot initially. The eyelid is everted to assure the surgeon that no penetration of the needle through conjunctiva occurs; if it does, the needle should be removed and repassed. The patient is then asked to open and close the eyes. Contour is best assessed with the patient sitting
up, though it is often difficult to do this in the partially sedated patient unless it is planned for in the intraoperative period, the surgical table allows it, and sterility is assured. A slight overcorrection of 1 to 1.5 mm is desired.

If the eyelid is still ptotic, an advancement of the levator aponeurosis on the front surface of the tarsus is performed. A larger bite of aponeurosis is now taken, and this leading edge is advanced and attached to the front surface of the tarsus in horizontal mattress fashion, performing an edge-to-edge imbrication of advanced levator onto the tarsus. Again, the edges are tied in a single slip knot. The leading edge of the levator is trimmed once eyelid height and contour have been verified in the upright position.

The contralateral side is operated simultaneously so that both sides can be assessed, because the laws of reciprocal innervation apply both postoperatively and in the operating room [7]. The authors prefer to attach

Fig. 10. Levator advancement. (A) Eyelid crease is drawn with a sterile marking pen. (B) Tenting of the orbicularis to facilitate dissection of the muscle from the orbital septum. (C,D) Identification of the superior tarsal border. (E,F) Passage of a nonabsorbable suture through the levator aponeurosis.
the levator using a single suture technique; many surgeons may prefer to secure the levator using two to three sutures.

Once eyelid height and contour have been verified and symmetry is created, the sutures are trimmed when the desired height is achieved. A blepharoplasty can also be performed at this time if needed. The skin is closed with several 6-0 absorbable interrupted sutures, incorporating a small bite of aponeurosis to reform the eyelid crease. A 6-0 running suture is then used to close the skin and antibiotic ointment is applied both into the eyes and onto the surfaces of the wounds (Figs. 11 and 12).

Levator advancement surgery in children is performed in much the same manner, though intraoperative assessment is more difficult without the patient’s cooperation while under general anesthesia. As a consequence, the results can be more unpredictable because the level of the eyelid cannot be checked intraoperatively. There are two popular methods used to estimate the amount of levator advancement necessary. Levator function can be used to assess the amount of surgery function technique, which bases the height on the levator function [6]. If the levator function is 5 to 6 mm, the height of the lid is adjusted to the desired level and fissure height; in situations in which levator function is less, the lid must be adjusted higher. An alternative to this approach involves using MRD$_1$ to calculate the amount of levator advancement. With this technique, the levator is advanced a specific amount based on the patient’s preoperative MRD [6].

Levator resection

Levator resection is a procedure that can be used in children who have congenital ptosis or in adults who have acquired ptosis. The amount of

![Fig. 11. A 61-year-old patient showing bilateral aponeurotic ptosis preoperatively (A) and after levator advancement surgery (B).]
levator resected is determined preoperatively by levator function and the level of ptosis. Dissection is often extensive and involves dissecting the levator from the underlying Muller’s muscle and the conjunctiva, as well as disruption of the medial and lateral horns of the levator. Because the authors are often are able to achieve our aesthetic and reconstructive aims with advancement surgery or Whitnall’s slings, both less invasive procedures, levator function is not performed in our practice.

**Whitnall’s sling**

A Whitnall’s sling is performed in a similar manner to levator advancement surgery. It is used in patients with ptosis with poor levator function and as an alternative to brow suspension.

The eyelid crease is marked, local anesthesia is administered, the eyelid is incised, the orbital septum is incised, and the levator aponeurosis is identified. Whitnall’s ligament is identified and the aponeurosis is separated from Muller’s muscle as in levator advancement. A permanent silk or nylon suture is then passed through Whitnall’s ligament and is attached directly to the superior border of the tarsus. Closure is the same as in the levator advancement procedure.

**Conjunctivo-mullerectomy**

If a patient has a positive response to 2.5% or 10% Neosynephrine, a mullerectomy can be performed to correct a mild to moderate amount of
ptosis. After administering local anesthesia, the eyelid is everted over a desmarres retractor. Two 4-0 silk sutures are placed at the lateral and medial aspect of the conjunctiva and Muller’s muscle and held at a 45° angle to tent the conjunctiva and Muller’s muscle. A Putterman mullerectomy clamp (Karl Ilg, Chicago, IL) is placed to incorporate Muller’s muscle and conjunctiva only. Local anesthesia is injected to balloon up and separate Muller’s muscle from the levator aponeurosis. A double-armed suture is passed from lateral to medial through conjunctiva and Muller’s muscle. A 15 blade is used to remove the conjunctiva and Muller’s just inferior to the suture. The sutures are then weaved back through the conjunctival edges in running fashion, being careful to avoid exposure of the suture to prevent corneal irritation. The ends of the suture are brought anterior through the skin and loosely tied over the eyelid crease. Often a collagen shield is placed to protect the cornea.

New algorithms are created as techniques are created or improved. A fairly easy algorithm to use for ptotic patients with a positive Neo-synephrine test has been developed. The formula estimates the amount of conjunctiva and Muller’s muscle to be resected. The formula is 9 mm of conjunctiva and Muller’s plus x mm of tarsus, where x is equal to the distance of ptosis undercorrection after phenylephrine testing. The study presenting the new formula had a 0% overcorrection rate and a 3% reoperative rate [21].

Tarsococonjunctival/superior tarsal resection

Tarsococonjunctival/superior tarsal resection or the modified Fasanella-Servat procedure is a surgical option for patients who have mild ptosis and good levator function such as in Horner’s syndrome. This procedure is not recommended for patients who have moderate dry eye, because a portion of the conjunctiva and basic tear secretors will be resected [1,6].

Because of this objection, we have not performed this procedure in practice over the past 20 years, though it is employed by many surgeons and will be described below for completeness.

The procedure is performed after the upper eyelid is injected with local anesthetic. The eyelid is everted over a Desmarres retractor. Two small curved hemostats are used to grasp conjunctiva, Muller’s muscle, tarsus, and occasionally a small amount of levator fibers (Fig. 13A). The hemostats are placed on the tarsus about 3 mm from the superior edge with the blades of the hemostats running parallel to the tarsus border. A 5-0 suture with a reverse cutting needle is passed from medial to lateral through the eyelid approximately 1 to 1.5 mm above the hemostats (Fig. 13B). The hemostats are removed and the tissue is removed above the suture in the midportion of the clamped area (Fig. 13C). One must be careful to avoid cutting the running suture. The suture is then passed lateral to medial within the crushed remaining tissue. Both needles are passed through the anterior
surface of the eyelid skin and tied loosely across the upper eyelid. The final results can be seen in 2 weeks to 2 months.

**Frontalis sling**

The frontalis sling is commonly used to treat a ptotic child or adult with poor levator and good frontalis function [6,7]. The purpose of the procedure is to use a sling material such as silicon or autogenous or allograft fascia lata to connect the upper eyelid tarsus to the frontalis muscle [6,7]. The patient then employs the frontalis muscle to open the eyelid. The choice of sling material depends on the age of the patient and the duration of the need for

Fig. 13. Tarsoconjunctival resection. *(A)* Two clamps are placed to grasp the conjunctiva, Muller’s muscle, and superior tarsus. *(B)* The running suture is passed through all three tissues. *(C)* The clamped tissue is excised while making sure the suture is not cut.
the sling. Fascia lata can be harvested from the patient’s thigh or obtained from a fascia bank.

Two sling strips are usually needed for each eyelid. Fascia lata harvested from the patient is normally long enough to be used after a child has grown past the age of 4. Silicone or suture slings can be used in small children until their growth allows fascia to be harvested [7].

The surgery is usually performed under general anesthesia for children and monitored anesthesia in cooperative adults.

To obtain fascia, a 3-cm skin incision is made on the lower lateral thigh with the leg and foot internally rotated after infiltration with local anesthetic. The incision is made 1 cm above the knee in a line between the anterior iliac crest and the head of the fibula in adults and adolescents and 2 cm above the knee along the same line in children [21]. The incision is made above the knee joint in an imaginary line between the head of the fibula and the anterior superior iliac spine (Fig. 14A). The skin and subcutaneous tissue is dissected to reveal the fascia lata, which is white. A scalpel is used to make parallel incisions on the fascia about 5 to 8 mm apart. A long scissors is passed between the plane of the fascia and subcutaneous tissue superiorly and beneath the fascia. A fascia stripper can then be inserted and the fascia is thread into the stripper (Fig. 14B). The fascia is severed with the sharp edge of the stripper or a blade, then removed. The usual length is about 10 cm. The fascia is then cleaned of connective tissue and can be divided into 2- to 3-mm strips to be used for ptosis repair (Fig. 14C). The fascia layer does not have to be closed. The site is closed with deep subcutaneous sutures and skin closure with staples or sutures. Steri-strips followed by a pressure dressing are then applied. Ambulation can resume 12 to 24 hours after surgery.

The strip can be positioned in the shape of a pentagon using only one strip (Fox technique) or using two strips shaping each one in the shape of the triangle (Crawford technique) [22]. The Crawford technique, the authors’ preferred technique, will be described herein.

The placement of the strips begins with marking of the incision site (Figs. 14D and 14E). Using a sterile marking pen, the eyelid crease is marked. Three additional marks are made: one approximately at the level of the superior brow hairs nasal to the pupil 1 to 2 cm, one approximately above the lateral canthus immediately above the brow hairs, and one just lateral to the medial canthus above the brow hairs. Local anesthesia with adrenaline is then injected and the patient is prepped and draped in the usual fashion. A #15 blade is used to incise skin down through the dermis to the subcutaneous plane at the three premarked brow incisions, beveling the blade so as to avoid injury to the brow hair follicles. The incision is then dissected to the level of the frontalis using a blunt scissors.

An eyelid crease incision is made through skin and is deepened through the orbicularis and septum to identify the levator muscle/aponeurosis, which can be rudimentary in the case of patients who have severe ptosis. The
superior half of the tarsus is exposed by sharp dissection. The central aspect of the sling is sutured to the upper third of the tarsus in the point of greatest curvature in the eyelid, slightly nasal to the pupil. It is then sutured medially to the tarsus, slightly medial to the limbus. The second strip is attached to the tarsus at the peak, the two strips are overlapped, and the second strip is sutured approximately at the level of the lateral limbus. The strips are then passed with a large cutting free needle or a fascia passer under the septum, out the corresponding brow incisions laterally, and sutured to the frontalis after checking eyelid contour. The location of the fascia with respect to the frontalis may be altered with suture to achieve symmetry and contour. The skin crease incision is then closed with interrupted 6-0 absorbable sutures, attaching the skin directly to the fascia to create an eyelid crease. The interrupted sutures can be used to form an eyelid crease by passing the suture through the skin edge, incorporating a small bite of tarsus and then

Fig. 14. Fascial sling procedure. (A) Incision of the leg. (B) Harvesting of the fascia with the stripper. (C) Cutting the strips into the correct size. (D,E) Correct placement of the fascial slings in the Crawford technique.
passing it out the other skin edge. A running 6-0 absorbable suture is then placed. The strips are then pulled superiorly to adjust the lid height at the level of the superior limbus. Each strip is tied with a square knot over a piece of 5-0 nonabsorbable suture and fixated to frontalis to assure that the knot will not slip. One end of the strip is then cut 1 cm from the knot and each long end is then passed out the central brow incision with the passer or the free needle. The two long sides are then tied and the ends are trimmed. The ends under the frontalis muscle with forceps and the brow incisions are closed with 6-0 nonabsorbable nylon or prolene sutures. A frost suture can be placed to prevent exposure in the early postoperative period (Fig. 15A, B).

Silicone slings

A silicone rod can also be used instead of fascia with a few differences in the procedure. A single rod is used so it is attached to the tarsus and passed through the same marked incisions and/or overlapped over a silicone sleeve that is sutured to the central brow incision. Silicone is a good choice in patients that require adjustment, such as patients who have myopathic ptosis or severe ptosis accompanying dry eye. Silicone can easily be adjusted with a small incision in the central forehead incision,

Fig. 15. A 5-year-old patient showing right-sided congenital ptosis preoperatively (A) and after ptosis surgery with a fascial sling (B).
and either tightened or loosened. The silicone does not scar into the tissues as much as fascia, making it easier to adjust or remove, but it can become infected. It also may cheese wire through tissue, making it less effective over time.

Special cases

Unilateral ptosis in Marcus Gunn syndrome

Patients who have Marcus Gunn syndrome have a unilateral ptosis and other problems to address other than the ptosis. When the ipsilateral pterygoid muscle is stimulated, the ptotic eyelid retracts and makes the ptosis improve [17]. The treatment of the ptosis can be addressed with the Fasanella-Servat procedure (in patients with good levator function), but this often worsens the eyelid retraction associated with jaw movement. More commonly, some type of sling procedure is required. The surgeon has multiple options that often must be discussed with the parents. A unilateral sling may be performed, or bilateral surgery can also be performed, which improves the overall asymmetry. In this situation, either disinsertion of the abnormally innervated levator either alone or accompanied by the contralateral disinsertion of the normal levator can be performed [17]. According to one study, the best procedure is performing a bilateral fascial sling procedure with a disinsertion of the contralateral (the nonptotic side) levator muscle [17]. Most parents in our practice, however, prefer not to have the contralateral normal levator disturbed, at least at the time of the primary procedure.

Third-nerve palsy

Most patients with a third-nerve palsy are more concerned about the motility abnormality than the ptosis. The ptosis surgery may not be performed if the motility abnormality cannot be corrected, because the patient may experience diplopia. The ptosis is usually best corrected with a frontalis sling or levator advancement [7]. All patients must be evaluated for aberrant regeneration before ptosis surgery to select the correct surgical procedure.

Unilateral ptosis

Unilateral ptosis should be managed based on its etiology and the levator function. Preoperative evaluation is especially important in these patients so that the surgeon can ascertain that the ptosis is truly unilateral. Often correction of a unilateral acquired ptosis will reveal a contralateral ptosis, especially if the dominant eye is ptotic, as the drive to elevate the fellow eye will disappear once the dominant eye ptosis is corrected. In patients who have severe unilateral ptosis, it is often difficult to make both eyes “match,”
because even when the eyes are symmetric in the primary position, lid closure may be compromised and ptosis will remain in upgaze. Any of these ptosis procedures can be combined with blepharoplasty if redundant skin or fat is present. Blepharoplasty techniques are discussed elsewhere in this issue.

New advances

Small incision surgery

Small incision surgery consists of a levator advancement or resection with an incision only 8 mm in length instead of across the entire length of the upper eyelid [23]. The surgery is performed as the regular levator advancement surgery, except that extra skin and fat are not excised. Patients needing a blepharoplasty or who have had prior eyelid surgery are not ideal candidates for this procedure [23]. The goal of the minimal incision surgery is to speed recovery time [23].

Adjustable suture surgery

Given the inherent inaccuracy of adjustable techniques, the possibility of performing this surgery on adjustable sutures is an intriguing one and has been explored by several investigators [3]. The theory behind the adjustable suture is to decrease the amount of reoperations. One recent technique uses a “hang-back” suture similar to the adjustable suture that is used in adult strabismus surgery [3]. A double-armed 5-0 silk suture is passed horizontally, incorporating a bite of midline aponeurosis 5 to 6 mm in length. The suture ends are passed through the tarsus 6 to 10 mm apart, straddling the midline of the tarsus. The suture is tied loosely in a bow and is brought to the skin surface, where it is secured with a prolene suture. The patient uses ice compresses at home and undergoes adjustment by postoperative day 4. The results from these initial studies are encouraging, with somewhat lower reoperation rates [3].

Postoperative care

The authors usually recommend applying ice compresses to the eyelids for 48 to 72 hours after surgery and applying an ophthalmic antibiotic ointment to the incisions twice a day for 3 days. The patient can shower the day after surgery, taking care not to let the water from the shower head hit directly on the eyelids. The authors also recommend that the patient avoid exercise or heavy lifting for 2 weeks. Patients can resume their preoperative prescriptions medicines the day after surgery—with the exception of blood thinners, which can be resumed at 2 weeks, unless they are deemed essential by the patient’s internist.
Complications of ptosis surgery

The most common “complications” of ptosis surgery are not true complications but instead are part of the inherent inaccuracy of the procedure; that is, undercorrections and overcorrections [1]. The rate of occurrence of overcorrections or undercorrections varies from 5% to 35% depending on the series. In the authors’ experience, undercorrections are much more frequent than overcorrections. Overcorrections are more worrisome because in addition to the inherent cosmetic defect, patients can suffer from exposure keratopathy and are frequently uncomfortable. Overcorrection is usually more common in bilateral, aponeurotic ptosis; undercorrection is more common in congenital ptosis [4]. Massaging the eyelid downward may resolve or reduce an overcorrection [18]. Reoperating on patients with overcorrections should be done within 2 weeks of the original surgery after edema has resolved but before scarring has taken place [1,4,24].

True complications in ptosis surgery can also be seen accompanying overcorrections, making this postoperative state undesirable. These include lagophthalmos, lid lag, exposure keratitis, corneal ulceration, and visual loss [1].

Lagophthalmos can occur in the absence of overcorrection if sutures incorporate the septum and the levator aponeurosis, resulting in a “hangup” with eyelid closure [1]. Exposure keratitis can cause permanent vision loss and should be treated aggressively. Lubrication with artificial tears and ointments, bandage contact lenses, moisture shields, and temporary tarsorrhaphy can help treat the problem. If these more conservative approaches do not work, overcorrection surgery with levator recession is indicated [1]. The decision to reoperate is usually made within 2 to 6 months after the original surgery [1,6]. Studies by Dortzbach and colleagues [25], however, have shown that lid height 1 week postoperatively is comparable to that at 3 months postoperatively; thus there is a rationale to early revision within the first week of surgery, when tissue planes are freshly created. This principle is often used in the authors’ practice in the willing patient with overcorrection.

Hemorrhage in the postoperative period can negate the improvement following ptosis surgery and also cause vision loss. All patients should be warned about increasing swelling, bleeding, postoperative pain, and vision changes signaling hemorrhage [1,7]. Any of these occurrences should be reported to the physician immediately. Meticulous hemostasis should be maintained throughout the surgery to avoid this problem. Patients should also discontinue all blood thinners for 2 weeks before and 2 weeks after surgery with their doctor’s permission. If a patient has a tense or tight orbit and eyelids, proptosis, vision changes, or pupillary defect after surgery, the original surgical incision should be opened and all bleeding stopped with cautery before reclosure. An emergent canthotomy and cantholysis of the
lateral canthal tendon can be performed but usually is not necessary once bleeding is controlled.

Infection can occur but is unlikely, because the eyelids have an excellent blood supply. To avoid problems, many surgeons recommend application of an antibiotic ointment to the incision site during the immediate post-operative period [1,6,7]. Moist healing has been shown to be the quickest means of healing, and we recommend the use of occlusive ointments in the first 48 hours postoperatively. Blepharitis should be resolved or minimized before surgery to lessen the risk of infection.

Another important complication is the temporary change in vision after ptosis surgery [25]. Rarely, this change can be permanent [26]. The etiology of visual change relates to astigmatism from changes in the cornea related to the change in eyelid position. Most patients will have some degree of persistent astigmatism 3 months after surgery, but most have resolved by 12 months [26].

Other important but uncommon complications include entropion, ectropion, eyelid crease abnormality, lid margin notching, eyelash loss, symblepharon, conjunctival prolapse, and diplopia from damage to the superior rectus or oblique muscle [1,7].

Notching or tarsal kinks usually occur due to poor release of adjacent levator tissue, or advancement too far down on the front surface of the tarsus, and are a consequence of overly ambitious levator advancement. Ectropion and conjunctival prolapse can also be seen when aponeurotic advancement is overly robust. Management often involves takedown of the original procedure, excision of a small portion of tarsus, or excision of conjunctival prolapse.

All potential complications should be discussed with the patient before surgery. The risk of reoperation should be emphasized, because patients who submit themselves to a surgical procedure with the expectation of taking care of the problem with a single surgery are often discouraged to be informed that further intervention is required.

References


