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Review of Recent Advances in the Ptosis Treatment of the Upper Eyelid: Review Literature

Akhmedov Sh. S.
Senior Teacher, Central Asian Medical University, Fergana, Uzbekistan
Corresponding author email: shahnozaid@mail.ru

Abstract---*The article provides a literary review of the methods of surgical correction of blepharoptosis. The methods are divided into the following groups: upper blepharoplasty, operations with hanging the upper eyelid to the frontalis muscle, operations with various methods of shortening the eyelid levator muscle, operations with the attachment of the levator of the eyelid to the upper rectus muscle of the eye, Muller's muscle resection technique. The advantages and disadvantages of these methods are indicated.*
Keywords---*blepharoptosis, eyelid levator, frontalis muscle, levator resection, recurrence, suspension surgeries.*

Introduction

Ptosis of the upper eyelid (blepharoptosis) is one of the current topics in medicine. Its relevance is primarily due to the frequency of its spread among congenital and acquired soft tissue diseases of the per orbital zone. Thus, according to various authors, ptosis of the upper eyelid among ophthalmopathy was 15.6%, and the overall prevalence of hereditary eye diseases among the adult population was 2.42, and among children – 8.63 per 10000 people. The relevance of this disease is also associated with the fact that ptosis of the upper eyelid leads to various complications (Grishchenko et al., 2012; Filatova et al., 2021). Particularly problematic today is congenital blepharoptosis, which over time leads to disruption of the visual apparatus and to such complications as amblyopia, strabismus, binocular vision disorder –mono focus vision, astigmatism, sometimes not amenable to correction, hypermetropia, severe myopia. The overhang of the eyelids on the pupils reduces the field of view from above. Over time, with congenital ptosis of the eyelids, the posture changes, and the spine is deformed. With acquired ptosis, patients cannot strain their eyesight for a long time and increased fatigue, and headaches appear. This category of patients, in addition to physical changes, also suffer psychologically due to aesthetic inferiority, they avoid society. Unfortunately, the incidence of upper eyelid ptosis has recently increased due to the buildup of unfavorable factors, both social and hereditary (Uddin & Davies, 2002; Simon et al., 2005; Salimbeni, 1999). The urgency of this problem is added by the fact that today there is no well–established system for assisting this category of patients. This is due to the fact that today there is no clinical examination of patients with blepharoptosis, performed operations for ptosis of the upper eyelid are not always effective, and very often lead to various (from 17 to 40%) complications. The risk of postoperative complications increases with the severity of eyelid ptosis and decreased function of the eyelid levator. Sometimes these factors make the effectiveness of corrective operations impossible. Of the currently existing methods of surgical treatment of ptosis of the upper eyelid, the most widely used are operations with resection of the levator muscle of the eyelid and operations of hanging the eyelid to the eyebrow. However, these techniques are not without drawbacks and often lead to complications, such as recurrence of ptosis, hypercorrection, lagophthalmos, and suture granuloma 32.4% (Filatova et al., 2021). After operations, the eyelid often loses its protective, closing function, which can lead to keratitis and conjunctivitis. Operations with resection of the levator of the eyelid cannot be used in children under 15 years of age. This leads to the fact that before adolescence, uncomplicated ptosis of the eyelids passes into complicated forms.

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Object of research

We have worked out the literature of recent years with various methods of surgical and conservative treatment of patients with various forms of eyelid ptosis of various age groups.

Purpose of the study

To study the effectiveness of modern methods of treating eyelid ptosis and, on the basis of this, improve the efficiency of surgical correction of patients with upper eyelid ptosis with maximum preservation of the functionality of the upper eyelid. Methods for the treatment of blepharoptosis can be divided into conservative and surgical. Some (Ryabtseva et al., 2015), suggest combining conservative therapy with surgical methods for correcting eyelid ptosis. At the same time, the authors believe that conservative treatment is more indicated for children under 5 years of age because the use of more radical methods in this category of patients is associated with a high risk. According to the literature, there are currently many (more than 100) surgical procedures, which can be essentially divided into the following groups:

1) Upper blepharoplasty. Cosmetic pure blepharoplasty is able to level ptosis by approximately 2.8 ± 0.6 mm, which can have a very significant impact on the result of surgical elimination of true ptosis in a combination of levator surgery and cosmetic blepharoplasty. According to Grishchenko S.V. upper blepharoplasty is indicated for persons with age-related changes in the upper eyelids and with blepharochalasis (Grishchenko, 2012; Grishchenko, 2007).
2) Suspension operations or operations with the suspension of the upper eyelid to the eyebrow in order to use the frontal abdomen of the quadriceps muscle of the head (hereinafter referred to as the frontalis muscle) to lift the eyelid (Zaĭkova & Shevtsova, 1974; Ivolgina, 2016; Kataev & Zakharova, 2017; Filatova, 2015; Filatova et al., 2021; Filatova & Shemetov, 2017; Congenital ptosis repair, 2013). The essence of these operations is that a tunnel is created through a notch above the eyebrow for holding a thread or other material to the upper eyelid. As a result of this operation, an additional link appears between the eyelid and the muscle that lifts it, which acts as an intermediary. Thus, the eyelid–eyelid levator muscle complex turns into the eyelid–material mediator–muscle complex, which plays the role of the eyelid levator (frontal muscle). Or from two–link to three–link. One end of the material is attached to the soft tissues above the eyebrow, and the other end to the upper eyelid. There are many modifications to this technique. This technique was first used in 1881 by Pagenstecher–Hess, who placed temporary sutures between the frontal muscle and the upper eyelid. Subsequently, the fascia lata of the thigh was widely used as a suspension material (Wright, 1922, Crawford, 1977), in various modifications. These techniques are not currently used due to rough scarring at the site of fascia sampling and because of the fragility of the result. Various authors use tendons. The main disadvantage of this material used is its fragility. Over time, the tendon lyses, which leads to a recurrence of the process. Some researchers suggested attaching the upper eyelid to soft tissues with special submerged sutures without any skin incisions. Skin and muscle flaps were used as suspension material (Operation Rose 1924). The operation of strengthening the muscle that lifts the upper eyelid according to the Roberts method in the modification of Colin and Fuchs is based on cutting out two or three pedunculated flaps from the frontal muscle and bringing them through a tunnel to the upper edge of the cartilage of the upper eyelid (Zaĭkova & Shevtsova, 1974). Muscular suspension is also used from the circular muscle of the eye according to the method of Khatsukov (1977). The essence of the operation is to cut out muscle flaps from the orbital portion of the orbicular muscle of the eye, pass them through the subcutaneous tunnel and fix them to the tarsal plate (Zaĭkova & Shevtsova, 1974). However, they did not become widespread over time. The upper eyelid was suspended using various materials (cotton, nylon, silk thread, tantalum wire, carbon textile, rubber thread, alloderm threads, and polypropylene thread). Over time, tapes from various materials were proposed as suspension materials: mersilene mesh, PTFE, silicone tape, ULTRAPRO mesh, etc. All these methods are highly traumatic and lead to various complications, such as suture granuloma, contouring of the material, violation of the shape of the palpebral fissure, scars, and abscesses. All these methods, as it turned out, are also short–lived. Recurrence after suspension surgery usually develops up to 2 years (Frontalis Suspension, 2005). Fibers of the orbicular muscle of the eye have been proposed as a suspension material (Zaĭkova & Shevtsova, 1974). There are reports of a combined suspension of the eyebrow and to the ligament of Wintal. Due to unstable results, these techniques are used to a limited extent. Due to frequent relapses, the followers of this technique began to attach a suspension material above the eyebrows to the central part of the frontalis

muscle. So, on June 17, 2021, a technique was published with hanging the eyelid to the forehead with poor or no levator function (RF Patent No. 2749802, 2021). The inventors describe the technique as less traumatic. In this case, polypropylene threads are used as suspension material. Make two incisions in the eyelid and superciliary region. One incision in the central area of the forehead. Through mini incisions in the eyelid area, a suspensory material is passed with a disposable 18 G needle behind the orbicular muscle of the eye, along the anterior surface of the tarsal plate, and then along the levator (Sharma, 2015; Rosado et al., 2018; Grove Jr, 1981). The ends of the suspension material are brought out into an incision on the skin of the forehead. The upper eyelid is pulled up so that its edge is located along the upper limb. Further, the ends of the suspension material are fixed to the frontal muscle. This group of operations is performed today only when it is impossible to perform a radical operation to correct ptosis due to the lack of function of the eyelid levator or as a temporary measure when a radical operation cannot be performed for various other reasons. For example, children under 15 years old. However, a technique has recently been published for eyelid suspension using a 4:0 polypropylene thread with intact silt and reduced levator function (RF Patent No. 2749802, 2021). None of these techniques is ideal and eventually leads to relapses. In this regard, patients are forced to undergo surgical treatment several times in the course of life or completely abandon surgical interventions.

3) Operations with shortening of the eyelid levator muscle. This group can include two types of methods:
   a) Creation of duplication of the levator muscle without its excision. This technique can be used for minor ptosis and good contractility of the levator eyelid. The simplest of these operations is the creation of duplication from the aponeurosis of the levator muscle (Everbush operation, 1883). Many have modified this technique and use it in various modifications to this day (Ivolgina, 2016; Obodov et al., 2011). These techniques are characterized by ease of execution, low trauma, low complication rate, and good performance, provided that patients with mild blepharoptosis and good levator function are selected well. The closing function of the eyelid is preserved, a good aesthetic result is achieved. Its only drawback is its limited application.
   b) Levator resection followed by suturing. In the literature, this group of techniques is described and studied most deeply (Ivolgina, 2016; Kataev & Zakharova, 2017; “Guide to eye surgery”, 1988). This group is considered the most effective of all existing methods and covers a wide range of patients with various degrees of ptosis. In 1963 L.Kh. Shotter and A.V. Gerasimov proposed a simplified method for the operation of strengthening the muscle that lifts the upper eyelid by resection. They calculated the volume of the resected muscle as follows: to raise the eyelid by 1 mm, it is necessary to resect 2–3 mm of the levator muscle tissue. These techniques include the technique of resection of the tarsal plate. The essence of this technique is the transverse excision of the tarsal plate, followed by suturing with the levator of the eyelid (Blashkovich operation). Very often, surgeons simultaneously resect the levator of the eyelid with the tarsal plate in order to correct ptosis. Despite its great efficiency, this group of operations is also not without drawbacks. Thus, according to publications, hypoeffect after surgery is 8–26% of the total number of operated patients (Kataev et al., 2018; Kuwabara et al., 1975; Whitehouse et.al., 1995). The outcome of the operation can also be lagophthalmos with a violation of the closing function of the eyelid. The frequency of postoperative complications led to the search for the “golden mean” – the optimal volume of levator resection based on the degree of blepharoptosis, the function of the eyelid levator (Berke, 1958; Beard et al., 1995; Iliff, 1979), by dynamometry, on based on the histological calculation of the volume of muscle tissue of the levator muscle (Potemkin & Goltsman, 2019). Of interest are techniques with simultaneous resection of the eyelid levator muscle and simultaneous suspension of the eyelid to the frontal muscle with a mersilene mesh, in severe ptosis. This search continues. For ptosis of the 1st degree, according to the results of histological studies of the resected areas, the presence of muscle fibers in the volume from 1/2 to 1/3 is characteristic, for ptosis of the 2nd degree, muscle fibers are present in the volume from 1/3 to 1/4 of the total volume, for ptosis of the 3rd degree individual bundles of striated muscles are characteristic. The severity of congenital blepharoptosis is due not only to a decrease in muscle fibers that affect the force of levator contraction but also to their replacement with connective tissue: dense fibrous, loose fibrous, and fatty. This greatly affects the extensibility and strength of the levator, limiting the use of resection technologies. Of particular interest is a group of techniques with the creation of a duplication levator after its separation from the tarsal plate and suturing to it in a new area. In 2015 Korotkikh S.A. et al. described a technique for the surgical treatment of upper eyelid ptosis with preserved or reduced levator function. After resection of the levator muscle refixed to the anterior surface of the tarsal plate. However, despite the relatively sufficient effectiveness of this group of techniques, it has its limitations (Wijemanne et al., 2017; Stein et al., 2014; Simon et al., 2005). It is impossible to apply

these techniques if the elevator is not functioning or there is poor function of the levator of the eyelid in combination with grade 2–3 eyelid ptosis. In addition, levator shortening technologies definitely increase the risk of developing lagophthalmos. Muscle fibers have their own stretch limit, and by shortening the muscle, we limit its extensibility. An unmodified muscle fiber can stretch up to 150% of its length. In the case of congenital ptosis, muscle fibers have less extensibility, which means that their resection in large volumes can increase the risk of complications. Very often, the levator can be presented as a thin connective tissue plate, which makes it impossible to use this group of techniques. All authors of this group of methods recommend switching to suspended technologies in such cases.

4) A group of techniques with suturing the eyelid levator to the superior rectus muscle of the eye: the Mote operation proposed in 1903 and its modification proposed by Burke in 1953 (Kurbanov et al., 2009; Ryabtseva et al., 2015). In this technique, the eyelid levator is sutured directly to the superior rectus muscle of the eye. In fact, the technique attracts attention in that the levator eyelid muscle and the superior rectus muscle of the eye work synergistically, and attachment of the eyelid to this muscle leads to an improvement in the functionality of the eyelid. However, this technique has received very limited use due to the complexity of the operation, the development of diplopia, and an insignificant effect.
5) In the 70s, Burd proposed the technique of tarsusectomy (Müller's muscle–conjunctival resection, 2012). According to him, resection of the aponeurosis for the correction of ptosis of the upper eyelid is insufficient. Tarsusectomy significantly increases the effect of lifting the upper eyelid. Subsequently, in 1975, Putterman and Urist phasanella Servat developed a technique – conjunctival resection of Muller's muscle. According to Bookman, resection of the tarsal plate should be minimal due to the fact that the tarsal plate is the main frame of the upper eyelid and its resection leads to deformity of the upper eyelid. Recently, many researchers have begun to promote the technique with resection of the superior tarsal muscle (Muller muscle) without resection or with partial resection of the tarsal plate (Dzagurova, 2020; Congenital ptosis repair, 2013; Müller's muscle–conjunctival resection, 2012). According to these authors, one of the causes of acquired ptosis of the upper eyelid is fatty degeneration of the superior tarsal muscle, which leads to a decrease in its contractility. To determine the dysfunction of this muscle, a test with a 2.5% solution of phenylephrine is proposed. In the case of a positive test, it is resected. Various algorithms for resection of the tarsal muscle have been proposed depending on the degree of response to phenylephrine. Recently, a number of authors have reported the possibility of resection of the superior tarsal muscle with negative or weakly positive phenylephrine test results, provided that the levator muscle function is good. In 2002, Perry J.D, Kadakia A., Foster J.A., and 2003 Lake S. et al. proposed a technique for simultaneous resection of the superior tarsal muscle with dosed resection of the tarsal plate. In 2019 Potemkin V.V. et.al. proposed their own method for determining the magnitude of resection of the tarsal plate with resection of the superior tarsal muscle in case of weakly positive and negative responses to the phenylephrine test, depending on the mobility of the white line. This technique captivates with its low trauma and efficiency. The negative effects of this technique include a decrease in the area of the conjunctival fornix and a decrease in basal tear production. The indication for resection of the tarsal muscle is acquired mild to moderate ptosis without or with a slight impairment of levator function, which significantly limits its use (Morley et al., 2010; Cruz et al., 2013; Huijing et al., 2014).

In scientific publications of recent years, more and more attention is paid to the properties of the tissues of the upper eyelid in order to develop tactics for the treatment of ptosis (Filatova et al., 2012). Thus, the elastic–strength properties of the skin of the upper eyelid, the levator eyelid, and the circular muscle of the eye in congenital and acquired ptosis of various origins were studied. According to these authors, the elasticity, extensibility, and tensile strength of the skin and levator of the eyelid in congenital ptosis are changed and are directly proportional to the severity of ptosis. With age, biomechanical parameters in congenital ptosis deteriorate, which indicates the development of a pathological process. Ptosis in this case is combined with the weakness of the circular muscle of the eye. With age, the tendency to disrupt the biomechanical properties of this muscle also increases. The biomechanical properties of the tissues of the upper eyelid in acquired ptosis, according to the authors, are different. With senile ptosis, the extensibility of the skin and the levator of the eyelid increases and its elasticity decreases. The eyelids become atonic (Grishchenko, 2012). With ptosis of traumatic origin, the biomechanical parameters of the skin deteriorate significantly. The authors attribute this to the development of the cicatricial process of eyelid tissues. The elastic–strength properties of the eyelid levator in this case change insignificantly. In patients with myopathy, they are comparable with those in the group with acquired ptosis of non–traumatic origin. Interesting data are given on the biomechanical parameters of eyebrow tissues. A relatively high modulus of elasticity in combination with a low degree of extensibility characterizes the skin of the eyebrow area as more rigid (Filatova et al., 2012). No less

interesting are the measurements of the contractility and degree of elasticity of the eyelid levator. According to his data, the degree of contractility of the levator of the eyelid in congenital blepharoptosis ranges from 1 to 7 grams. At the same time, the force required to lift the levator of the eyelid and establish the norm position depends on the degree of ptosis and reaches up to 27 g. The contractility of the levator increases with the increasing mobility of the upper eyelid and vice versa decreases with increasing severity of ptosis. The elasticity of the levator, according to the author, is low (9 mm), medium (10–15 mm), and high (16 mm and above). The elasticity and contractility of the eyelid levator depend on the preserved muscle fibers. When analyzing the data, the groups of myasthenic and neurogenic ptosis do not differ from each other. The groups of acquired, congenital and traumatic ptosis also do not differ from each other. Traumatic damage to the periorbital zone leads to various consequences, depending on the damaging factor, and damage to various structures of the periorbital zone (Zaĭkova & Shevtsova, 1974). In such cases, in addition to complete or partial ptosis, there may be scarring of the skin of the eyelid, lymphocytosis, and external or internal strabismus. Scars can be combined with defects of the ciliary margin, deformity of the eyelids, and cicatricial degeneration of the entire inner canthus. In this case, the rupture of the internal ligament leads to a significant displacement of the palpebral fissure towards the temple. This in turn disrupts the function of the levator. Traumatic destruction of the transorbital fascia leads to the development of blepharochalasis. And to an even greater extent violates the function of the levator. With a fracture of the upper edge of the orbit, the levator is often infringed by bone fragments. The levator in such cases is pulled up and grows together with the periosteum of the upper wall of the orbit. Injuries accompanied by a detachment of the soft tissues of the periorbital zone lead to retraction and gross eversion of these zones. So, tearing off the tissues of the upper eyelid will lead to the development of cicatricial lagophthalmos, in the lower eyelid this will lead to cicatricial eversion of the eyelids.

One of the problems is the postoperative ability to close the eyes. The issues of choosing the age of patients when it will be possible to perform surgical correction of blepharoptosis remain controversial. Taking into account the high traumatism of more effective surgical techniques, the authors propose to perform resection technologies at the age of 15 years. At the same time, attempts are being made to objectify the effectiveness of surgical correction of upper eyelid ptosis. In 2014 Gushchina M.B., Egorova E.V. proposed their own method for evaluating the effectiveness of surgical treatment of upper eyelid ptosis (Gushchina et al., 2020). In this case, the width of the palpebral fissure is measured before and after the operation. The symmetry coefficient is measured before and after the operation, and the efficiency of the operation is determined by the difference in the coefficients. If the difference exceeds 20%, then the operation is considered effective. The search for scientific approaches to improve the tactics of correcting ptosis of the upper eyelid continues. In recent years, researchers are increasingly inclined to believe that surgical correction of upper eyelid ptosis should be differentiated and offer different standards for ptosis correction depending on the degree of ptosis and the function of the eyelid levator (Ivolgina, 2016).

1) The choice of the method of surgical treatment of ptosis should be based on pathogenetic principles – the degree of drooping of the upper eyelid and the function of the levator:
   a) with preserved or reduced function of the levator (5–9 mm), its resection should be performed;
   b) with minimal ptosis and preserved or partially reduced levator function (10–12 mm), duplication is possible levator;
   c) with a significantly reduced function of the levator (3–4 mm and below), as well as in its absence, the upper eyelid should be suspended from the eyebrow with modern materials.
2) The use of a differentiated pathogenetically substantiated method for the treatment of ptosis of the upper eyelid allows you to get a good cosmetic effect, as well as a good functional result (increased mobility of the upper eyelid and the absence of lagophthalmos).
3) Compliance with a differentiated pathogenetically substantiated approach to the treatment of ptosis, taking into account the cause of its occurrence, can reduce the possibility of postoperative complications.

When analyzing the literature of recent years, we did not find studies on vector disorders of the pathology of the periorbital zone and correction based on these disorders.

Conclusions

1) Today, ptosis of the upper eyelid is one of the urgent problems of the pathology of the periorbital zone.
2) The current methods of surgical treatment of ptosis of the upper eyelid do not always lead to the improvement of patients, and often lead to relapse of the disease and various complications, the most common of which are relapse of ptosis and lagophthalmos. As a result, further improvements are required.

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