



# Postoperative levator function change in patients with unilateral myogenic versus aponeurotic blepharoptosis

Mohsen Bahmani Kashkouli\*, Parya Abdolalizadeh, Anahita Amirsardari, Houri Esmaeilkhanian, Mahya Ghazizadeh, Farideh Moradpasandi

Eye Research Center, Rassoul Akram Hospital, Iran University of Medical Sciences, Sattarkhan Niayesh St., Tehran 1455364, Iran

Received 24 July 2018; accepted 12 June 2019

## KEYWORDS

Blepharoptosis;  
Levator resection;  
Levator function;  
Myogenic ptosis;  
Aponeurotic ptosis

**Summary Purpose:** To compare the change in levator function (LF) after levator resection in patients with unilateral myogenic (MP) and aponeurotic ptosis (AP).

**Methods:** In a prospective study, patients of >5 years old were included from June 2015 to April 2017. Other types of ptosis, associated strabismus and previous eyelid surgery were excluded. Eyelid examination and photography were performed before and at least 6 months after surgery. Success was defined as Margin reflex distance 1 (MRD1) of within 0.5 mm of the unoperated side. All procedures (levator resection) were performed by or under supervision of one surgeon.

**Results:** There were 58 patients in the MP (mean age: 19.2 years) and 20 in the AP (mean age: 49.5) group with median follow up of 10 months. LF was significantly improved from 5.8 to 7.3 mm in the MP and from 11.8 to 13.6 mm in the AP group. LF improvement was not observed in 17.2% of MP and 25% of AP group ( $P=0.5$ ). Mean preoperative LF was significantly (Odd ratio = 1.8) higher in patients with than without LF improvement in the MP group. It was significantly reverse in the AP group (Odd ratio = 0.38). A significantly positive ( $r=0.30$ ) and negative ( $r=-0.72$ ) correlations were observed between preoperative LF and LF improvement in the MP and AP groups, respectively. Success was observed in 90% of AP and 84.5% of MP group. In order of frequency, undercorrection, overcorrection, and contour abnormality were the reasons for failure. No variable significantly affected the success rate in either group.

Part of this article has been presented at the annual meeting (Rapid fire) of European Society of Ophthalmic Plastic and Reconstructive Surgery (ESOPRS), Bucharest, September 2018.

\*Corresponding author.

E-mail addresses: [info@eyeplasticsurgeries.com](mailto:info@eyeplasticsurgeries.com), [mkashkouli2@gmail.com](mailto:mkashkouli2@gmail.com) (M.B. Kashkouli).

<https://doi.org/10.1016/j.bjps.2019.06.005>

1748-6815/© 2019 British Association of Plastic, Reconstructive and Aesthetic Surgeons. Published by Elsevier Ltd. All rights reserved.

**Conclusion:** Majority of MP and AP showed postoperative LF improvement. While higher preoperative LF was significantly correlated with LF improvement in the MP, it was reverse in the AP group. Success rate was not significantly different between the groups and no factor significantly affected the success in either group.

© 2019 British Association of Plastic, Reconstructive and Aesthetic Surgeons. Published by Elsevier Ltd. All rights reserved.

## Introduction

Blepharoptosis is defined as downward displacement of the upper eyelid in which two most common types are myogenic (MP) and aponeurotic (AP) ptosis.<sup>1</sup> While weak levator function, lid lag in down gaze, and absent or faint lid crease are clinical features for MP, good levator function, more ptosis in downgaze, and high lid crease are characteristics for AP.<sup>1,2</sup>

Levator muscle function (LF) is the most important factor for planning the ptosis surgery.<sup>2,3</sup> Levator resection procedure has been suggested for both myogenic and aponeurotic ptosis for its high success and low complication rates as well as preservation of normal anatomical tissue planes.<sup>4,7</sup> There are 4 retrospective studies<sup>5,8-10</sup> on LF improvement after levator resection procedure. Two of them included congenital myogenic ptosis,<sup>5,9</sup> one<sup>8</sup> included different types of MP including blepharophimosis and jaw wrinkling, and one<sup>10</sup> studied on just blepharophimosis syndrome. However, there is, to the best of our knowledge, no prospective study in this regard, no data on comparing post-operative levator function change between myogenic and aponeurotic ptosis as well as factors affecting it after levator resection procedure.

Therefore, this study was designed to compare the LF change and success rate after levator resection procedure in patients with unilateral myogenic ptosis (MP) and aponeurotic ptosis (AP) and analyse the factors affecting them.

## Material and method

This is a prospective, before and after study on patients with unilateral MP and AP who referred to a university based hospital (Rassoul Akram Hospital, Tehran, Iran) and senior author's (MBK) private clinic from June 2015 to April 2017. Informed consent and ethic committee approval (IUMS-9211257002) were obtained and the study adhered to the tenets of the Declaration of Helsinki. A specific ptosis examination form was completed for all the patients (Figure 1). Included were patients with more than 5 years of age and unilateral ptosis with margin reflex distance 1 (MRD1) of more than 1.5mm lower than the normal side who either had congenital myogenic or acquired aponeurotic ptosis. Patients with previous eyelid surgery, extraocular myopathy, aberrant nerve regeneration, poor Bells' phenomenon, third nerve palsy, strabismus, congenital or acquired eyelid deformity, levator function of  $\leq 3$  (requiring sling procedure), and concurrent blepharoplasty and or other procedures were excluded.

MRD1 and MRD2 are the distance between the upper and lower eyelid margins to the corneal reflex when the

patient is fixating the light source, respectively (Figure 2). MRD1 of less than 4mm is considered ptosis (Figure 2(a)). Levator surgery increases the MRD1 to improve the ptosis (Figure 2(b)). Severity of ptosis was divided into mild ( $\leq 2$  mm), Moderate ( $2 < \text{MRD1} < 4$ ), and severe ( $\geq 4$  mm). LF was assessed by measuring upper eyelid excursion from extreme down to upgaze while pressing over the patient's eyebrow to cancel the action of frontalis muscle. Besides recording the absolute value of LF (mm), it was divided into poor ( $\leq 4$  mm), fair (5-7 mm), good (8-10 mm), or excellent ( $\geq 11$  mm). Measurements were taken by the same observer (MBK) before and at the last follow up.

Skin approach levator resection was performed (supplementary film) for all the patients under local or general anesthesia by or under direct supervision of the senior author (MBK). Type of anesthesia was based on patient's age and cooperation. Intra-operative adjustment (sitting and supine) was performed for the patients under local anesthesia (1.5-2 ml of Lidocaine 2%+ adrenaline 1/200,000). A modification of Berke's guideline<sup>11</sup> was used to set the upper eyelid under general anesthesia based on LF. The aim was to put the MRD1 one mm higher than the fellow eyelid (1 mm overcorrection), intraoperatively. Levator muscle was finally secured on anterior tarsus using 5-0 vicryl suture (3-6 horizontal mattress sutures). Crease forming skin closure (6-0 Nylon) was performed and dressing with topical steroid (hydrocortisone) and antibiotic (Tetracycline) ointment was put on the incision for 1 day. Dressing patch was removed one day after surgery and two ointments were continued for 1 week when skin sutures were removed. They were also instructed to put artificial eye drop (4 times a day) and ointment (on sleeping). Follow up was set on day 1, week 1 and at least 6 months after the procedure.

Success of ptosis repair was defined as MRD1 within 0.5 mm of the fellow eyelid at the last follow up. Photos (primary gaze, downgaze, 2 lateral views) were taken before and at the last follow up time.

Main outcome measure was comparing the change in LF after the procedure and factors affecting it. Secondary outcome measure was to compare the success rate and factors affecting the success between the two groups.

Statistical analysis was performed using SPSS for Windows software version 16 (SPSS, Inc, USA). A *P*-value less than 0.05 was considered statistically significant. Mann-Whitney U test (continuous variables), Chi-square test (categorical variables), Wilcoxon rank test (comparing pre- and postoperative continuous variables), binary logistic regression model (factors affecting the success and LF change), and spearman correlation (preoperative LF and postoperative LF change) were used for analysis.

**Blepharoptosis Form**

Name:.....; Sex:.....; Date: ...../...../..... Phone No. :..... Chart No..... Age:.....;		
<input type="checkbox"/> Right <input type="checkbox"/> Left; Since <input type="checkbox"/> Birth / ..... ago; Previous eyelid surgery: ..... History of: <input type="checkbox"/> Trauma, <input type="checkbox"/> Surgery, <input type="checkbox"/> Systemic dis.: ..... Aggravated in: <input type="checkbox"/> Evening, <input type="checkbox"/> Morning; <input type="checkbox"/> Family Hx of ptosis; Medication: <input type="checkbox"/> ASA, <input type="checkbox"/> Anticoagulant		
	Right	Left
Eye motility		
MRD1 (mm)		
MRD2 (mm)		
Levator function (mm)		
Crease		
Eyelid lag in down gaze (+/-)		
Hering's law (+/-)		
Brow ptosis/ elevation		
Dermatochalasis		
Eyelid contour		
Synkinesis		
Bell's phenomenon (good/fair/poor)		
Anisocoria (mm)		
Phenylephrine test		
Corneal sensation		
Dry eye		
Contralateral lid retraction		
Lash ptosis grade (0-3)		

Figure 1 Blepharoptosis examination form for recording all the eyelid data.

**Results**

There were 78 subjects in whom 58 had MP and 20 AP. Mean age and LF (pre- and postoperative) were significantly higher in patients with AP (Tables 1 and 2) than MP. While mean MRD1 was not significantly different between the groups, severity of ptosis was significantly higher in the MP group (Table 1).

LF was significantly ( $P < 0.001$  for both groups) increased from 5.8 (SD = 1.4) to 7.3 mm (SD = 2.1) in the MP and 11.8 (SD = 1.9) to 13.6 mm (SD = 1.2) in the AP group. Its improvement, however, was not significantly different between the groups ( $P = 0.3$ ) (Table 2).

LF improvement was not observed in 17.2% (10/58) of patients in the MP and 25% (5/20) of patients in the AP group ( $P = 0.5$ ). Mean preoperative LF was significantly ( $P = 0.03$ , Odd ratio=1.8) higher in patients with (LF = 6.1, SD = 1.4) than without (LF = 4.9, SD = 1.2) LF improvement in the MP group. In sharp contrast, mean preoperative LF was significantly ( $P = 0.03$ , Odd ratio=0.3) lower in patients with (LF = 11.2, SD = 1.5) than without (LF = 13.8, SD = 1.7) LF improvement in the AP group. No other factors were significantly associated with LF improvement in either group ( $0.1 < P < 1$ ). A significantly positive correlation ( $r = 0.3$ ,

$P = 0.03$ ) was present between preoperative LF and the amount of postoperative LF improvement in the MP group (Figure 3). On the contrary, there was a significantly negative correlation ( $r = -0.7$ ,  $P < 0.001$ ) between preoperative LF and the amount of postoperative LF improvement in the AP group (Figure 4).

Success rate of surgery (Figure 2) was not significantly different between AP (90%, 18/20) and MP (84.5%, 49/58) groups (Table 2). Reasons for failure (14.1%, 11/78) were undercorrection (7/11, 63.6%), overcorrection (2/11, 18.2%), and contour abnormality (2/11, 18.2%). No variable significantly affected the success rate in either group (Table 3). Reoperation included levator resection (for undercorrection), levator recession (for overcorrection), and opening the levator attachment with realigning its position (for contour abnormality). All reoperations resulted in success.

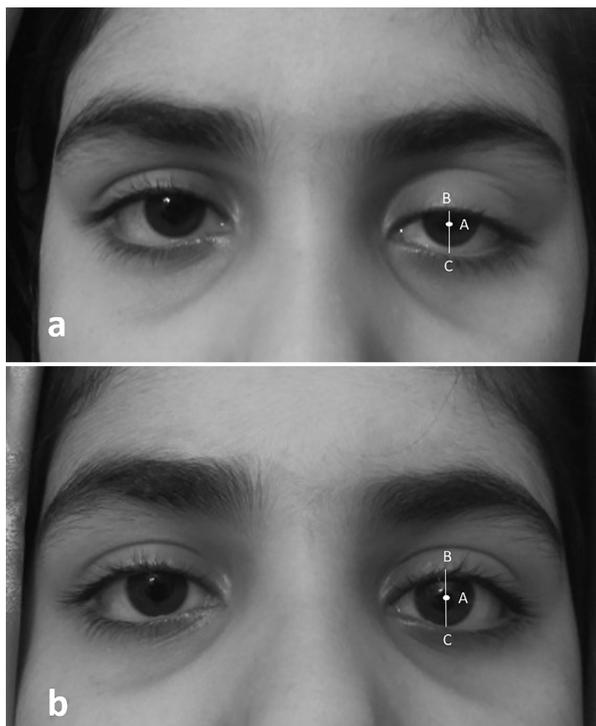
**Discussion**

Postoperative improvement of LF leads to a better symmetry of two eyelids especially in up- and downgazes.<sup>9</sup> It has been reported in 4 prior studies in patients with myogenic ptosis.<sup>5,8-10</sup> The first report was in 1959<sup>8</sup> in which

**Table 1** Demographics and eyelid measures in subjects with unilateral myogenic and aponeurotic ptosis.

		Myogenic (n = 58)	Aponeurotic (n = 20)	P-value
Age (years)	Mean (SD)	19.2 (6.01)	49.5 (12.8)	<0.001
	Median (IQR)	20 (16-23)	51 (36.5-61)	
Sex	Male	27/58 (46.6%)	7/20 (35%)	0.3
	Female	31/58 (53.4%)	13/20 (65%)	
Laterality	Right	32/58 (55.2%)	10/20 (50%)	0.6
	Left	26/58 (44.8%)	10/20 (50%)	
Follow up (months)	Mean (SD)	9.98 (2.5)	11 (2.7)	0.1
	Median (range)	10 (8-12)	11 (9-13)	
Margin reflex distance 1 (mm)	Mean (SD)	0.52 (0.9)	0.6 (1.06)	0.4
	Median (IQR)	0.50 (0-1)	1 (0.1-1)	
Severity of Ptosis	Mild $\leq 2$ mm	6/58 (10.3%)	7/20 (35%)	0.03
	Moderate 2 < MRD1 < 4	30/58 (51.7%)	8/20 (40%)	
	Severe $\geq 4$ mm	22/58 (37.9%)	5/20 (25%)	
Levator function (mm)	Mean (SD)	5.84 (1.4)	11.8 (1.9)	<0.001
	Median (IQR)	6 (5-7)	12 (10-14)	
Grading of levator function	Poor ( $\leq 4$ mm)	11/58 (19%)	0/20 (0%)	<0.001
	Fair (5-7 mm)	40/58 (69%)	0/20 (0%)	
	Good (8-10 mm)	7/58 (12.1%)	6/20 (30%)	
	Excellent ( $\geq 11$ mm)	0/58 (0%)	14/20 (70%)	

SD: standard deviation, IQR: interquartile range, MRD: marginal reflex distance.



**Figure 2** Before (a) and after (b) levator resection procedure for left eyelid ptosis. Margin reflex distance 1 (MRD1) increased from 1.5 mm (a; Line A-B) to 4 mm (b; line A-B). MRD2 (line A-C) was the same before and after the surgery.

2.2 mm LF improvement was observed in 87.7% of patients with congenital ptosis including patients with blepharophimosis and Marcus-Gunn jaw winking syndrome. Baker et al.<sup>9</sup>

also found 2.9 mm LF improvement in 81.2% of patients with congenital ptosis underwent levator resection. They commented that excision of dystrophic tissue and/or an improved mechanical advantage might explain such an improvement.<sup>9</sup> Likewise, LF improvement of almost 2.9 mm was observed in 83.4% of patients with myogenic ptosis in another recent study.<sup>5</sup> Since LF improvement continued even after 1 month postoperatively, they recommended that final LF should be measured some months after the surgery.<sup>5</sup> Furthermore, Decock et al.<sup>10</sup> observed a 5-mm LF improvement after supramaximal levator resection in 11 patients with blepharophimosis. They believed that presence of a very long and thin tendon inhibits the levator muscle from having sufficient impact on the vertical eyelid excursion.<sup>10</sup> Our results showed a 1.4-mm improvement of LF in 82.8% (48/58) of patients with MP. Lower amount of LF improvement, as compared with prior studies,<sup>5,9</sup> could be due to lower mean preoperative LF (5.8 mm) in ours versus others (6.8 mm<sup>5</sup> or 6.1 mm<sup>9</sup>). Similarly, AP group showed 1.7 mm LF improvement in 75% (15/20) of the patients to which there was no study to be compared to.

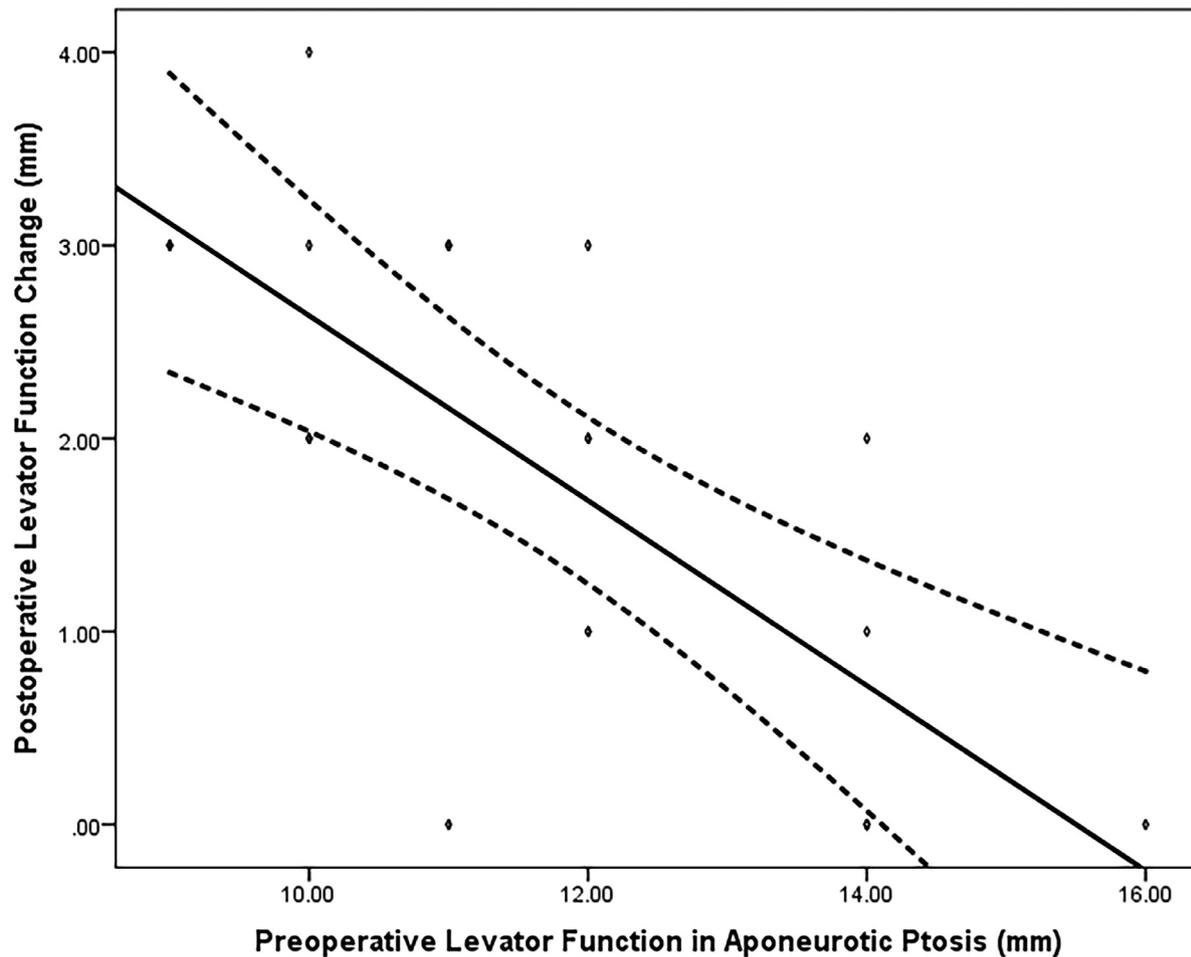
One interesting finding of our study was that LF improvement was directly correlated with preoperative LF in the MP and reverse in the AP group (Figures 3 and 4). Considering that maximum normal LF is mostly limited to 15-16 mm and preoperative LF is significantly lower than normal in the MP than AP group, it seems that range of expected LF improvement can potentially be higher in the MP than AP. In other word, in patients with AP and nearly normal LF, levator resection procedure does not furtherly improve the LF. Whereas, patients with MP do have much lower LF than normal to which more resection of the levator muscle can furtherly improve the LF.

Having such LF improvement after levator resection procedure would raise two questions in the clinical

**Table 2** Eyelid changes after levator surgery in subjects with unilateral myogenic and aponeurotic ptosis.

Variables		Myogenic (n= 58)	Aponeurotic (n= 20)	P- value
Success rate (%)		49/58 (84.5%)	18/20 (90.0%)	0.719
Postoperative margin reflex distance 1	Mean (SD)	3.5 (0.6)	3.3 (0.6)	0.1
	Median (IQR)	3.7 (3-4)	3 (3-4)	
Mean postoperative Levator function (mm)	Mean (SD)	7.3 (2.05)	13.6 (1.2)	<0.001
	Median (IQR)	7.2 (5-9)	14 (12.2-14)	
Grading of postoperative Levator Function	Poor	5/58 (8.6%)	0/20 (0%)	<0.001
	Fair	25/58 (43.1%)	0/20 (0%)	
	Good	25/58 (43.1%)	0/20 (0%)	
	Excellent	3/58 (5.2%)	20/20 (100%)	
Change in LF	Mean (SD) range	1.4 (1.09) (-1- 4)	1.7 (1.2) (0-4)	0.3

SD: standard deviation, IQR: interquartile range.



**Figure 3** Correlation (significant and positive) between postoperative changes and preoperative levator function in 58 patients with myogenic ptosis. The correlation line (solid line) and the 95% confidence interval (dotted lines) are shown.

practice. The first is when a re-operation is planned for an under-corrected previous ptosis repair. It is unclear if a new (after the surgery) or the original (before the surgery) LF should be the basis for planning the type of re-operation. For instance, a patient with preoperative levator function of 3 mm and undercorrection after levator resection procedure is now presented with 5 mm LF and is going to have re-operation. The question is if another levator resection procedure (based on LF of 5 mm) is recommended or the

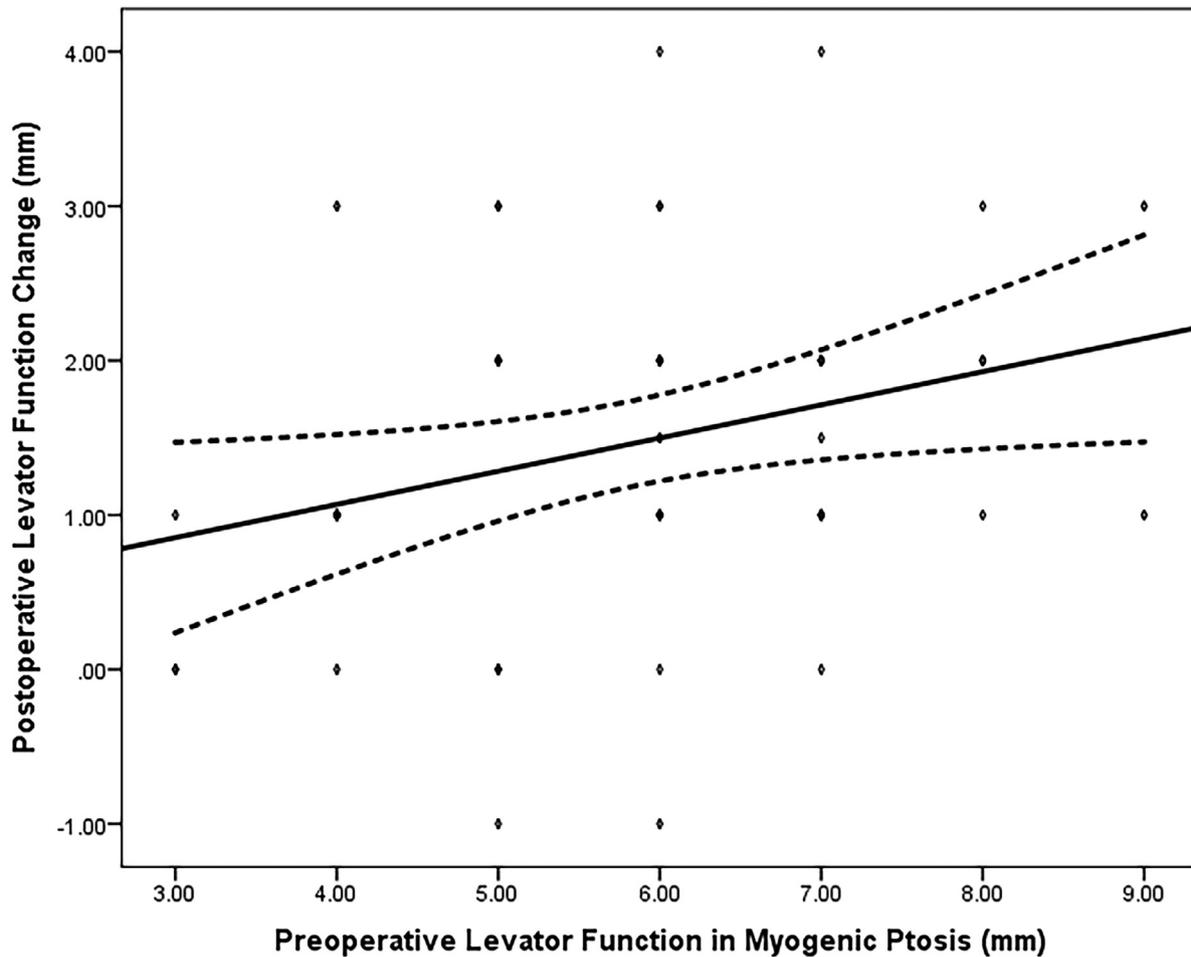
second operation should be sling procedure (based on LF of 3 mm and postoperative undercorrection). This could be a potential topic of future studies. The second question would be if such an improvement could be used to predict the amount of up- and down movement as well as amount of lagophthalmos after levator resection procedure which again could be studied in the future projects.

Different success rates after levator resection procedure is partly due to different definitions for the success.<sup>3,4,6</sup> To

**Table 3** Univariate analysis for factors affecting surgical success in subjects with unilateral myogenic and aponeurotic ptosis.

	Myogenic (58)			Aponeurotic (20)		
	Success (49/58, 84.5%)	Failure (9/58, 15.5%)	P value	Success (18/20, 90%)	Failure (2/20, 10%)	P value
Age (years)	20 (5.4)	15.1 (7.5)	0.1	49.4 (13.6)	50.5 (2.1)	0.9
Sex (Female%)	27/49 (55.1%)	4/9 (44.4%)	0.7	12/18 (66.7%)	1/2 (50%)	1
Mean MRD1 (mm)	0.4 (0.9)	0.7 (0.7)	0.5	0.6 (1.10)	0 (0)	0.09
Severity of ptosis	Mild $\leq 2$ mm	1/9 (11.1%)	0.1	7/18 (38.9%)	0/2 (0%)	0.4
	Moderate	7/9 (77.8%)		7/18 (38.9%)	1/2 (50%)	
	Severe $\geq 4$ mm	21/49 (42.9%)		1/9 (11.1%)	4/18 (22.2%)	
Mean levator function (mm)	5.7 (1.4)	6.2 (1.6)	0.4	11.7 (1.9)	13 (1.4)	0.3
Grading of levator function	Poor ( $\leq 4$ mm)	2/9 (22.2%)	0.5	0/18 (0%)	0/2 (0%)	1
	Fair (5-7 mm)	5/9 (55.6%)		0/18 (0%)	0/2 (0%)	
	Good (8-10 mm)	2/9 (22.2%)		6/18 (33.3%)	0/2 (0%)	
	Excellent ( $\geq 11$ mm)	0/9 (0%)		12/18 (66.7%)	2/2 (100%)	
Mean (SD) change in levator function	1.4 (1.1)	1.3 (0.5)	0.5	1.8 (1.3)	1 (0)	0.3

SD: standard deviation, MRD: marginal reflex distance.



**Figure 4** Correlation (significant and negative) between postoperative changes and preoperative levator function in 20 patients with aponeurotic ptosis. The correlation line (solid line) and the 95% confidence interval (dotted lines) are shown.

make cosmetically more acceptable, our definition of success for unilateral ptosis repair was to have the MRD1 within 0.5 mm of the un-operated side. Such a definition has been used in other studies in which 70-95% success rates have been reported in different types of ptosis.<sup>3,4,7</sup> Our success rate of 90% for AP and 84.5% for MP were similar to the previous reports in which, similar to Berlin's<sup>4</sup>, two most common types of ptosis (MP and AP) did not have a significant difference in their success rates. While some have reported a less success in patients with more severe ptosis<sup>4,10</sup>, others<sup>5,6</sup> did not find such an association. Likewise, some have reported that preoperative LF has a significant<sup>2,3,8</sup> effect on the success and some found it insignificant.<sup>4-6</sup> Controversy might be rooting from that different techniques, inclusion criteria, and age groups in different studies. We did not find any variable significantly affecting the success rate of levator resection procedure in patients with MP nor AP. We believe that when a surgeon chooses the right technique and amount of correction based on right preoperative severity of ptosis and LF, there should not be a significant difference in the success rates. Similar to other studies,<sup>4,5</sup> the most common and favorable complications in our series was undercorrection (7/11).

Limitation of this study might be unequal number of patients in two groups which was due to referral status of the study locations and not assessing the LF improvement on patients' satisfaction. Future studies are recommended to compare other types of ptosis and techniques with regard to the postoperative LF improvement, assess the correlation between LF improvement and up-/ down movement of the operated eyelid, and if new (postoperative) or original (preoperative) LF should be taken into consideration during re-operation of undercorrection of ptosis.

In conclusion, this is the first study on comparing postoperative LF improvement between patients with unilateral MP and AP in which a significant LF improvement was observed in both groups. While such an improvement had a significantly positive correlation with preoperative LF in the MP group, the correlation was significantly negative for the AP group. Success rate of levator resection procedure was not significantly different between the two groups and no variable significantly affected the success rate in either group.

### Conflict of interest

The authors have no commercial associations or sources of support that might pose a conflict of interest.

### Acknowledgments

All the authors read and agreed to submission. It was funded by Iran University Eye Research Center which did not have any role in the design, execution, and presentation of results.

### Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:[10.1016/j.bjps.2019.06.005](https://doi.org/10.1016/j.bjps.2019.06.005).

### References

1. Finsterer J. Ptosis: causes, presentation, and management. *Aesthetic Plast Surg*. 2003;**27**:193-204.
2. Anderson RL, Dixon RS. Aponeurotic ptosis surgery. *Arch Ophthalmol* 1979;**97**:1123-8.
3. McCulley TJ, Kersten RC, Kulwin DR, et al. Outcome and influencing factors of external levator palpebrae superioris aponeurosis advancement for blepharoptosis. *Ophthalm Plast Reconstr Surg* 2003;**19**:388-93.
4. Berlin AJ, Vestal KP. Levator aponeurosis surgery. A retrospective review. *Ophthalmology* 1989;**96**:1033-6.
5. Göncü T, Çakmak S, Akal A, Karaismailoğlu E. Improvement in levator function after anterior levator resection for the treatment of congenital ptosis. *Ophthalm Plast Reconstr Surg* 2015;**31**:197-201.
6. Lee JH, Aryasit O, Kim YD, Woo KI, Lee L, Johnson ON 3rd. Maximal levator resection in unilateral congenital ptosis with poor levator function. *Br J Ophthalmol* 2017;**101**:740-6.
7. Cruz AA, Akaishi PM, Mendonça AK, et al. Supramaximal levator resection for unilateral congenital ptosis: cosmetic and functional results. *Ophthalm Plast Reconstr Surg* 2014;**30**:366-71.
8. Berke RN. Results of resection of the levator muscle through a skin incision in congenital ptosis. *AMA Arch Ophthalmol* 1959;**61**:177-201.
9. Baker GR, Atherley CE, Harrad RA, et al. Increased levator function following anterior levator resection treatment for congenital ptosis. *Orbit* 2008;**27**:235-6.
10. Decock CE, Shah AD, Delaey C, et al. Increased levator muscle function by supramaximal resection in patients with blepharophimosis-ptosis-epicanthus inversus syndrome. *Arch Ophthalmol* 2011;**129**:1018-22.
11. Heher KL, Katowitz JA. Pediatric ptosis. *Pediatric oculoplastic surgery*. Katowitz JA, editor. Springer International Publishing; 2002. New York.