Original Article

The utility of margin-reflex distance in determining the type of surgical intervention for congenital blepharoptosis

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Aims: To evaluate the utility of margin-reflex distance (MRD) as an alternative to levator function (LF) in choosing the appropriate surgical procedure for congenital blepharoptosis. **Settings and Design:** This was a retrospective, observational study. **Subjects and Methods:** Records of patients with simple (dystrophic) congenital ptosis who were operated and followed for ≥6 months postoperatively and whose outcomes were deemed as successful were evaluated in the study. Success was defined as a MRD at the last postoperative visit of ≥3 mm. In all cases, levator resection was performed when LF was >4 mm and frontalis suspension when LF was ≤4 mm. **Statistical Analysis Used:** For statistical evaluations, LF was accepted as the gold standard parameter for deciding on the surgical intervention, and the optimum cutoff point for initial MRD was determined as the point at which sensitivity and specificity was highest at the receiving operating curve for the selection of surgical procedure. **Results:** Of one hundred and three eyes of ninety patients (44 female/46 male), levator resection was used in 44.7% and frontalis suspension in 55.3%. When the optimum cutoff point for MRD was determined as 0.5 mm, the sensitivity was 71%, specificity was 86%, and the area under the curve that represented the discriminative power of this parameter was found to be 0.826. **Conclusion:** The MRD at the cutoff point of 0.5 mm may be used as an alternative to LF to determine the type of surgical intervention in patients with congenital blepharoptosis whose LF cannot be reliably obtained in clinical evaluations.

Key words: Congenital ptosis, levator function, margin-reflex distance

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Surgical correction remains the mainstay treatment for the management of congenital dystrophic blepharoptosis.[1] The proper method of ptosis surgery is determined by levator function (LF), degree of ptosis, presence of head position, response to phenylephrine as well as surgeon's experience, and preference.[2-8] These factors have been investigated in several studies and have been shown to achieve a successful surgical outcome, but LF is regarded as the most identifiable predictive factor[9-11] and a key determining factor in choosing the appropriate surgical procedure for ptosis correction regardless of the degree and etiology of ptosis.[12] The traditional approach is the use of frontalis sling techniques for severe ptosis cases with poor LF (0–4 mm) while levator resection procedures are generally reserved for ptosis with fair (5–7 mm) to good LF (>8 mm).[7,11] However, in early childhood, LF may not be determined properly because of limited cooperation. This leads to uncertainty on the side of the surgeon as to determining the appropriate surgical method (i.e., levator resection vs. frontalis suspension) and thus a criterion which is more objective, quantitative, and whose evaluation is easier is required. An alternative may be the margin-reflex distance (MRD) 1 which is more objective than LF and easier to measure as a voluntary movement on behalf of the uncooperative child is not required.

In this study, the value of choosing of MRD1 instead of LF in determining the type of surgical procedure (frontalis suspension or levator resection) for congenital blepharoptosis surgery was investigated and a cutoff point for MRD1 parameter for deciding on the optimum surgical procedure was sought.

Subjects and Methods

This was a retrospective study undertaken at a single academic setting. Chart records of patients with simple (dystrophic) congenital ptosis who were followed for ≥6 months postoperatively were included in the study. The study was conducted with approval from the Institutional Review Board. All surgeries were performed by or under direct supervision of a single surgeon. For all patients, data from the initial examination and the last postoperative visit were analyzed. The follow-up time was defined as the time between the final surgery and the most recent examination. For each examination LF, MRD1, ocular ductions, Bell phenomenon, and lid-lag were recorded when present. All subjects enrolled in the study had to have LF and MRD1 values. Either a modified Fox-Pentagon technique or an anterior approach levator resection was used for surgical corrections. LF was accepted as the gold standard parameter to differentiate between the surgical interventions. A successful outcome was defined as a MRD1 of ≥3 mm at

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the final postoperative visit. For study subjects included in this study, levator resection was performed on patients with LF >4 mm technique and frontalis suspension was performed on patients with LF ≤4 mm. Only the data of patients who achieved surgical success were included in the study as it was presumed that appropriate surgical procedure had been utilized in this group. Patients with unsatisfactory outcomes were excluded from the study. Patients with a history of any previous ocular or eyelid surgery, synkinetic movements of the upper lid and strabismus at first examination or during follow-up were excluded from the study. In addition, patients with Marcus-Gunn phenomenon and blepharophimosis syndrome in whom frontalis suspension technique is already indicated were excluded from the study. The optimum cutoff point for the preoperative MRD1 between patients who performed frontalis suspension and levator resection surgery was determined as the point at which sensitivity and specificity was highest at the receiver operating characteristic (ROC) curve for the selection of surgical procedure.

A receiver operating characteristic (ROC) curve graph is a technique for visualizing, organizing, and selecting classifiers based on their performance. In this study, LF was accepted as the gold standard and classification of the patients with surgically successful outcome according to LF was evaluated as actual/true class. Classification according to MRD1 was evaluated as predicted/hypothesized class. Inappropriate surgery selection, if results of MRD1 and LF were compatible, they were classified as true positive or true negative; if these results were not compatible, they were classified as false positive or negative. Selection of levator resection was accepted as positive classifier and selection of frontalis suspension was accepted as negative classifier. All statistical comparisons were made using the complete set of LF and MRD1 for the individual patients.

The frequency and percentages are given for the nominal data in the form of descriptive statistics. The receiver operating characteristic (ROC) curve analysis was used to determine the discrimination power of MRD1 inappropriate surgery selection, and the optimum cutoff point was evaluated at the point which has the highest sensitivity and specificity. For all statistical analysis, IBM SPSS Statistics for Windows, Version 20.0 (Armonk, NY: IBM Corporation Released 2011, NY, USA) was used.

Results

One hundred and three eyes of ninety simple congenital ptosis patients (44 female/46 male) with mean age of 10.2 ± 7.5 (78.9% <18 years) were evaluated. Of these, 42 had right eye (46.7%), 31 had left eye (34.4%), and 17 had bilateral (18.9%) involvement. Levator resection technique was used in 46 eyes of 45 patients (44.7%) and frontalis suspension technique in 57 eyes of 45 patients (55.3%). Of the 57 eyes which underwent frontalis suspension, 37 received autogenous fascia lata (64.9%), and 20 received allograft fascia lata (35.1%). There was a positive linear correlation between the LF and MRD1 at first examination ($P < 0.001$, $r = 0.458$) [Fig. 1]. The average MRD1 was 0.4 ± 1.1 mm at preoperative examination and 3.2 ± 0.4 mm at the last postoperative examination ($P < 0.001$) [Figs. 2 and 3]. The optimum cutoff point for MRD1 to differentiate between the appropriate surgical intervention was determined as 0.5 mm. Patients whose initial MRD1 was <0.5 mm fared better when frontalis suspension was used. On the other hand, patients whose initial MRD1 was ≥0.5 mm fared better when levator resection was used. At the cutoff MRD1 of 0.5 mm, the sensitivity was 71%, and specificity was 86% according to the ROC. When the optimum cutoff point of 0.5 mm was used at which the highest sensitivity and specificity for the selection of appropriate surgical technique was attained, the area under the curve that represented the discriminative power of this parameter was found to be 0.826 [Fig. 4].

In Fig. 4, the plain diagonal line y = x represents the strategy of randomly guessing a class. For example, if a classifier randomly guesses the positive class half the time, it can be expected to get half the positives and half the negatives correct; this yields the point (0.5, 0.5) in ROC space. The method generates a set of thresholds to sample, then for each threshold it finds the corresponding point of each ROC curve (dashed line) and averages them. Of these set of thresholds, the optimum cutoff point at which the highest sensitivity and specificity for selection of appropriate surgical technique was determined as 0.5 mm for MRD1, and it had been accepted as 4 mm for LF as a gold standard parameter as previously stated. Sensitivity represents the true positive rate, and 1-specificity represents the false positive rate.

Discussion

The crucial aspect of a successful end-result in blepharoptosis surgery rests on the proper selection of the appropriate surgical intervention.[13] In this aspect, the function of the levator muscle is reported as the single most important factor in selecting the correct type of procedure.[14] LF is determined by the excursion of the upper lid from downgaze to upgaze, without the contribution of the frontalis muscle. However, the determination of LF needs a voluntary movement of the eyelid, and in children younger than 4-year-old and patients with mental disorders, LF is often difficult to assess.[14-16] It is possible to estimate the excursion by watching the patient from a distance and observing eye and lid elevation, frontal contraction as well as the lid crease position. Patients with

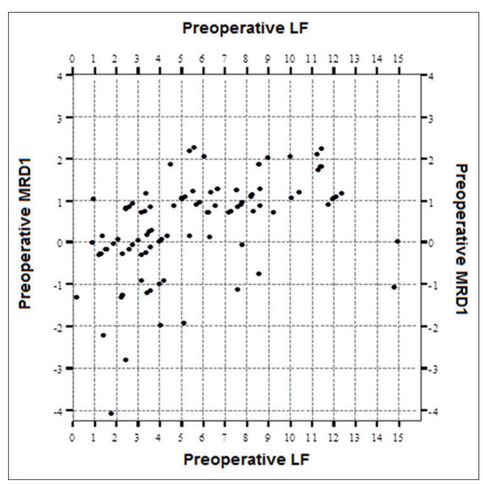

Figure 1: Distribution of preoperative levator function and margin-reflex distance parameters in patients with congenital blepharoptosis. There was a positive linear correlation between the preoperative levator function and margin-reflex distance 1 values ($P < 0.001$, $r = +0.458$)

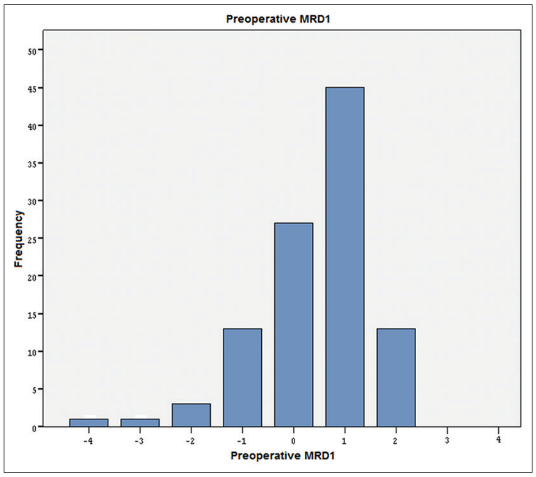

Figure 2: Frequency of preoperative margin-reflex distance 1 values in patients with congenital blepharoptosis

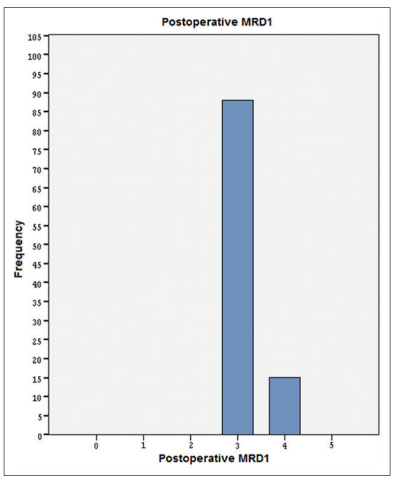

Figure 3: Frequency of postoperative margin-reflex distance 1 values in patients with congenital blepharoptosis

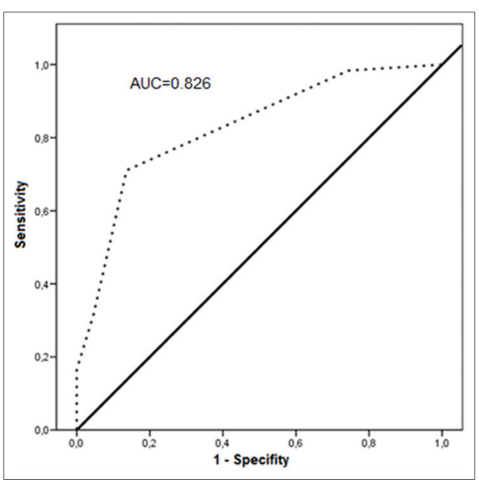

Figure 4: Association of margin-reflex distance 1 and appropriate surgery selection using a receiver operating characteristic curve according to levator function in the study subjects (AUC represents area under curve)

excessive frontal contraction and discreet or absent lid crease generally have poor LF.[14] To overcome this challenge in young and cooperative patients, special ptosis assessment spectacles have been designed to this effect and with high reproducibility and reliability, but they have not received widespread acceptance in clinics.[17] For assessment of LF more objectively, slit-lamp mounted digital photography system with computerized eyelid measurement analysis have also been proposed.[18,19] Again, these methods lack the ease of use in preschool children. Thus, it is evident that an unmet need exists for an objective, quantifiable, and easily assessable clinical parameter to determine the appropriate surgery selection.

MRD1 is a commonly used parameter in the assessment of patients with blepharoptosis and is defined as the distance between the upper lid margin and the corneal reflex when the eye is in the primary position. The normal value ranges between around 4.0 and 4.5 mm.[20] The MRD1 is the most important measurement in clinical practice to determine the presence of blepharoptosis. In severe cases, values of zero or less may be present.[14] Since the determination of MRD1 does not need a voluntary movement, its measurement is more objective and easier to obtain than LF. MRD1 is also used to grade the severity of ptosis as mild, moderate, and severe.[14] Our study and prior studies in the literature demonstrates that MRD1 is correlated with LF.[21] In general, mild ptosis is associated with good LF (>8 mm), moderate ptosis with fair LF (5–7 mm), and severe ptosis with poor LF (1–4 mm).[22-25] Thus, a relation already exists between MRD1 and LF and these parameters are interdependent.

Levator muscle function is currently the most important and the most commonly utilized parameter for choosing the type of ptosis surgery.[9,14] The classical approach in the selection of appropriate surgery for blepharoptosis is to select levator resection technique when LF is equal to or higher than 4 mm[26] and frontalis suspension technique when LF is lower than 4 mm.[3,8,20,27-31] This choice is based on the fact that strengthening of LF may only be achieved if there is sufficient levator excursion. For cases with absent or minimal LF, operating on the levator muscle will not satisfactorily improve the upper eyelid position.[32]

Cetinkaya and Brannan evaluated the findings of the previous studies on surgical correction of blepharoptosis and proposed an algorithm for appropriate surgical selection with utilization of LF and MRD1 parameters in their study.[33] According to that study, the traditional approach is to use frontalis suspension procedures with poor LF and prefer alternative methods depending on MRD1 in eyes with considerably better LFs. It is also emphasized in that study that the amount of LF usually corresponds to the severity of ptosis and is the major determinant of surgical approach.[33] As such, there does not appear to be a clear consensus on the role of alternative clinical parameters (apart from LF) used in surgery selection for treatment of blepharoptosis. The results of our study suggest that MRD1 may be used as a secondary parameter to determine the surgical approach in patients with congenital blepharoptosis. To the best of our knowledge, there has not been a similar published study looking into the value of MRD1 using ROC methodology to determine the appropriate surgical intervention. It is our opinion that our findings are important as this is the initial study demonstrating the discriminative power of MRD1 inappropriate surgery selection and which determines the objective and quantitative cut-off point for MRD1 as a clinical parameter.

The major limitation of this study is its retrospective nature. It is impossible to ascertain whether MRD1 measurements were obtained in all cases without proper brow relaxation. In addition, the MRD1 was not used to differentiate between mild and moderate LF to select between levator resection and mullerectomy/fasanella procedures. In addition, our results may only be applicable to those with simple dystrophic congenital blepharoptosis.

Conclusion

Our results suggest that a cutoff point of 0.5 mm for MRD1 may be used to determine the type of surgical intervention in congenital blepharoptosis in cases, in which LF cannot be reliably obtained. However, the findings of the current study need to be validated by a prospective study to clarify and better understand the utility of MRD1 in determining the appropriate surgical procedure for congenital blepharoptosis.

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Conflicts of interest

There are no conflicts of interest.

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