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ARTICLE

The aspect ratio of the palpebral fissure as a new blepharoptosis parameter

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ABSTRACT

Although the margin reflex distance (MRD) is widely used to assess blepharoptosis, it has some drawbacks (e.g. inaccuracy in severe ptosis). A new parameter is desired. We digitally analyzed pre- and post-operative photographs of 95 patients with blepharoptosis. We set a rectangle with the vertical sides at the lateral and medial canthus and the horizontal sides at the highest and lowest points of the eyelids. We calculated the percentage of the vertical side (height) to the horizontal side (width) and defined this value as the vertical percentage of the palpebral fissure. The MRD and the vertical percentage values were strongly correlated (correlation coefficient 0.766). In the 77 bilateral cases, both sides showed significant improvement in vertical percentage (from 28.9 to 37.3%, right) and (28.7 to 36.1%, left). In the 18 unilateral cases, the affected side showed significant improvement in vertical percentage (from 29.6 to 38.7%), while the unaffected side showed no change. In the eight patients who underwent re-operation, the revised side's vertical percentage was not improved after the first operation (from 28.0 to 31.3%), and the revision significantly changed the vertical percentage to 39.0%. In the re-operated patients, the difference between the right and left sides decreased significantly from 6.7 to 1.9% post-revision. The aspect ratio of each palpebral fissure (the percentage of height to width) reflected the progression of blepharoptosis and the post-operative changes. The aspect ratio thus has the potential to be a new parameter for blepharoptosis.

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Introduction

The margin reflex distance (MRD) is widely used as a standard parameter for blepharoptosis. For the measurement of an individual's MRD, he or she is instructed to look at a light source, and then the distance from the patient's corneal light reflex to the upper eyelid is recorded [1]. Surgical treatment for blepharoptosis is usually indicated when the MRD is <2.5 mm, and ptosis is defined as severe when the MRD is <0 mm [2]. Although measuring the MRD is a simple and easy way to assess blepharoptosis, the MRD is one-dimensional and its measurement relies on the examiner's experience [3]. In addition, in cases of severe ptosis the MRD cannot be measured accurately, as there is no light reflex [4]. Moreover, when a camera is used to measure the MRD, the flash position has an influence on the result [5]. Under these circumstances, a new parameter for blepharoptosis is desired.

In this study, we focused on the aspect ratio of palpebral fissures. The width of a palpebral fissure does not change during the progression of blepharoptosis or after treatment. We hypothesized that the ratio of the height to the width of a palpebral fissure can be used as a new parameter for blepharoptosis. We digitally analyzed pre- and post-operative photographs of patients with blepharoptosis, and we used the analysis results to determine the usefulness of the aspect ratio of palpebral fissures for the assessment of blepharoptosis.

Methods

The study was approved by the institutional review board. 95 patients who had undergone levator aponeurosis surgery for blepharoptosis between January 2014 and December 2018 were included in the study. All of the operations were performed by the first author. The aponeurosis was advanced and sutured to the upper edge of the tarsus by means of a transcutaneous approach, as described [2]. The MRD was measured pre-operatively with a standardized method [1]. The patient was instructed to look at a light, and the distance from the patient's corneal light reflex to the upper eyelid was measured with a ruler.

Photographs were taken in all patients. To avoid the effect of optical distortion, we took all of the patients' photographs in a standardized setting, that is, with the same lens (Macro EF-S 60 mm; Canon, Tokyo, Japan) and at the same distance (0.75 m). Pre- and post-operative photographs of the patients were digitally analyzed with the PowerPoint program (Microsoft, Redmond, WA). We set a rectangle with the vertical sides at the lateral and medial canthus and the horizontal sides at the highest point of the upper eyelid and the lowest point of the lower eyelid. We calculated the percentage of the vertical side (height) to the horizontal side (width) and defined this value as the vertical percentage of the palpebral fissure (Figure 1).

The correlations between the patients' MRD values and the vertical percentage values, and the post-operative changes of the vertical percentage were analyzed with the JMP 12 program (SAS, Cary, NC). Correlations were analyzed with Pearson's correlation coefficient test. Comparisons between two groups were performed with Student's *t*-test. Multiple groups were compared by an analysis of variance (ANOVA) with corrections for multiple comparisons. Data are expressed as the mean ± standard deviation, and *p*-values <0.05 were considered significant.

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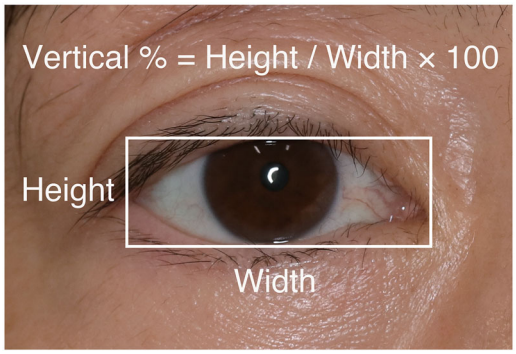

Figure 1. A schematic view of the digital image analysis of palpebral fissures.

Results

We reviewed 190 palpebral fissures of 95 patients (75 females, 20 males) aged 64.8 ± 16.0 years. The mean follow-up period was 4.6 ± 3.5 months. The MRD was measured in all patients pre-operatively, and the correlation between the MRD and the pre-operative vertical percentage obtained by our digital image analysis was evaluated. A strong correlation was observed between the MRD values and the vertical percentage values (correlation coefficient 0.766) (Figure 2). An MRD of −1, 0, 1, 2, or 3 mm corresponded to a vertical percentage of 20, 25, 30, 35, or 40%, respectively.

Seventy-seven patients underwent bilateral operations. Both sides showed significant improvement in vertical percentage, from 28.9 ± 5.7% to 37.3 ± 5.0% on the right side ($p < 0.01$) and from 28.7 ± 5.6% to 36.1 ± 4.9% on the left side ($p < 0.01$) (Figures 3 and 4).

Eighteen patients underwent unilateral operations. The affected side showed significant improvement in vertical percentage, from 29.6 ± 6.3% to 38.7 ± 4.2% ($p < 0.01$), while the unaffected side showed no change, from 37.8 ± 5.4% to 37.5 ± 4.0% (Figures 5 and 6).

Eight of the 95 patients (8.4%) underwent re-operations for the correction of asymmetry of the eyelids; all eight of these patients' cases were bilateral. The side with revision did not show significant improvement in vertical percentage after the first operation (from 28.0 ± 4.5% to 31.3 ± 4.1%), and the revision significantly changed the vertical percentage to 39.0 ± 4.1% ($p < 0.01$). The side without revision showed significant improvement after the first operation, from 26.4 ± 3.6% to 38.1 ± 4.3% ($p < 0.01$) (Figures 7 and 8).

We also analyzed the differences in vertical percentage between the right and left sides to assess the asymmetry of the eyelids. The patients who underwent re-operations showed a significantly greater difference in vertical percentage compared to the patients without re-operations after the first operation (6.7 ± 2.6% vs 2.0 ± 1.7%, $p < 0.01$). In the group of eight re-operated patients, the difference in vertical percentage between the right and left sides decreased significantly from 6.7 ± 2.6% to 1.9 ± 1.5% after the patients' revisional surgeries ($p < 0.01$) (Figure 9).

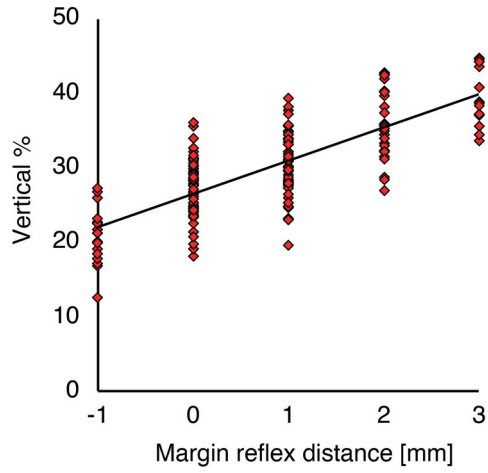

Figure 2. The correlation between the MRD and vertical percentage values. The correlation coefficient was 0.766.

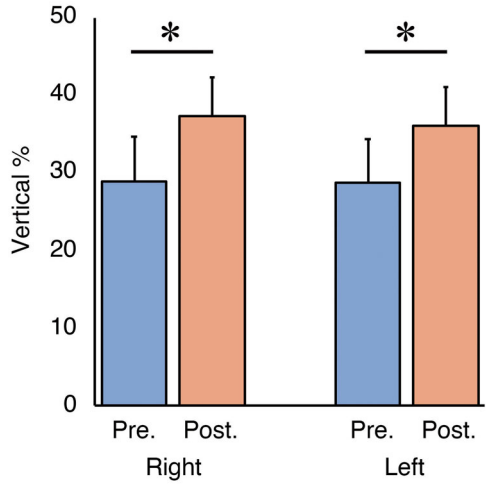

Figure 3. The pre- and post-operative vertical percentage values in the cases of bilateral blepharoptosis ($n = 77$, $^*p < 0.05$).

Figure 4. A representative case of bilateral blepharoptosis (a 23-year-old woman). The vertical percentage changed from 28.3 to 40.3% on the right side and from 27.1 to 39.6% on the left side.

Discussion

The results of our analyses revealed that the aspect ratio of a palpebral fissure can be used as a new parameter for blepharoptosis. The vertical percentage of 25% corresponded approximately to an MRD of 0 mm, and a 5% change in the vertical percentage was almost equal to a 1-mm change in the MRD. The aspect ratio (i.e. the vertical percentage) well represented the clinical status of blepharoptosis and the patients' post-operative results. Our findings also demonstrated that the aspect ratio was useful for the detection of postoperative asymmetry requiring re-operation, and for the evaluation of the improvement of the asymmetry after the revisional surgery.

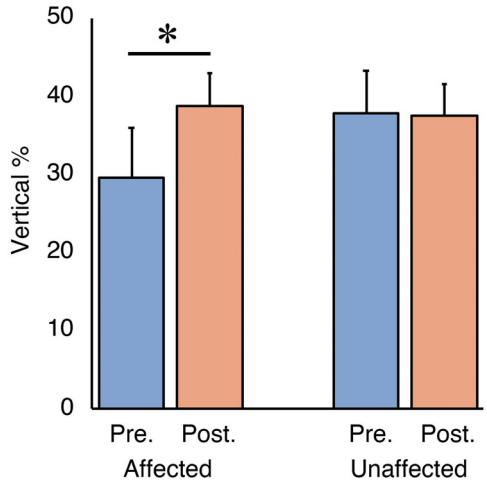

Figure 5. The pre- and post-operative vertical percentage values in the cases of unilateral blepharoptosis ($n = 18$, $^*p < 0.05$).

Figure 6. A representative case of unilateral (left) blepharoptosis (a 56-year-old woman). The vertical percentage changed from 36.6 to 37.4% on the right side and from 27.3 to 38.0% on the left side.

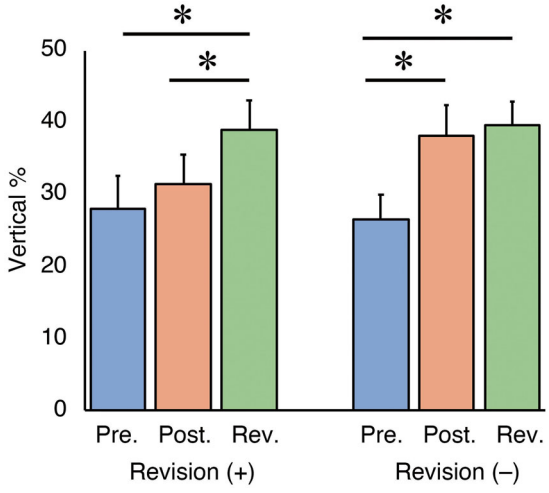

Figure 7. Changes in the vertical percentage after the initial operation and the revisional surgery in the patients who underwent re-operation ($n = 8$, $^*p < 0.05$).

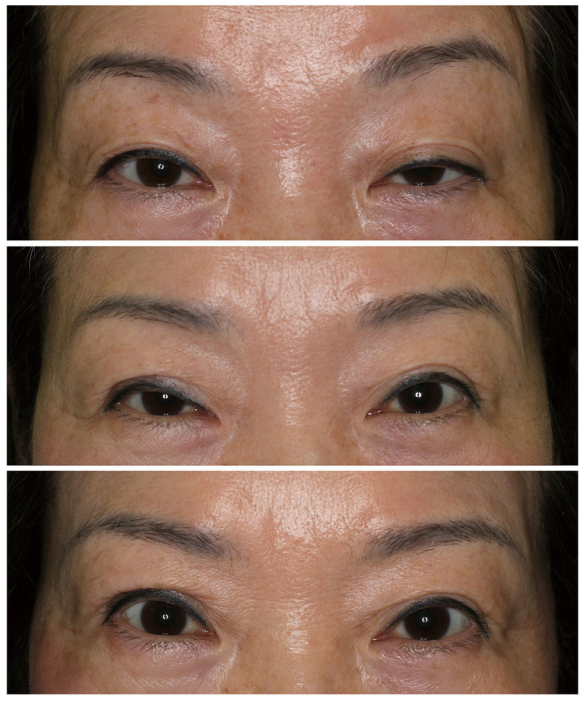

Figure 8. A representative patient who underwent revisional surgery (a 62-year-old woman). The vertical percentage changed from 30.9 to 29.1% on the right side and from 23.9 to 37.1% on the left side after the initial bilateral operation. The patient underwent re-operation on the right side. The vertical percentage was 37.5% on the right side and 38.9% on the left side after the revision.

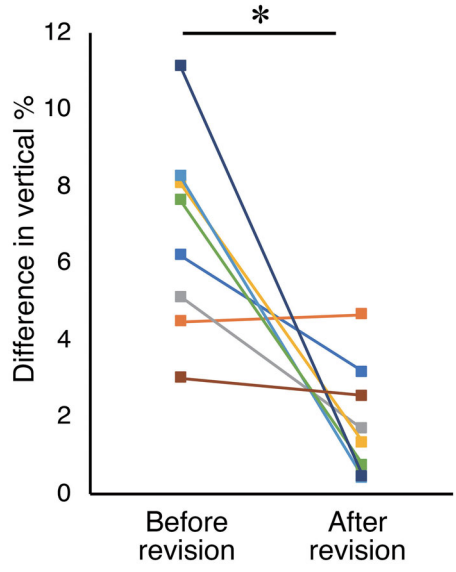

Figure 9. The differences in vertical percentage between the right and left sides before and after the revisional surgery ($n = 8$, $^*p < 0.05$).

Our new parameter has the following advantages over MRD. (1) The aspect ratio is more accurate than the MRD, and it reflects even slight changes after treatment. (2) The aspect ratio can be used in patients with severe ptosis, in which MRD cannot be measured accurately as there is no light reflex. Although a digital image analysis must be performed to obtain the aspect ratio of a palpebral fissure, such an analysis can be performed in a few minutes with the simple and commonly used software program PowerPoint. The degree of ptosis in a patient with a low lower-lid position (e.g. scleral show or ectropion) may be underestimated when our parameter is used. Even in such cases, however, the parameter can be used for assessing intra-individual changes.

Other digital image analyses for blepharoptosis have been reported. Nishihara et al. plotted the corneal limbus and measured the positions of the upper eyelid and the eyebrow based on

the corneal longitudinal diameter [4]. Park et al. analyzed the area of corneal exposure and reported that the percentage of the visualized corneal area to the total corneal area decreased with aging [6]. Choi et al. used the visual corneal percentage for the assessment of blepharoptosis [7]. Mawatari et al. analyzed the area of the upper eyelid shadow to assess the degree of sunken eyes in patients with blepharoptosis [8]. Although these methods are reliable and useful to varying degrees, all of these methods require a special software program for the analysis, and the procedures are more complicated than our new method.

With advances in technology, many useful tools for diagnosis protocols and surgical planning have been introduced in the field of plastic surgery. Automated measurements of the MRD with a software program have been reported [9,10]. Image processing software has been used to provide images that predict post-operative appearance after blepharoptosis surgery [11]. We believe that, in a similar way, the aspect ratios of palpebral fissures can be measured automatically, and in the near future predictive images can be made based on the aspect ratios. Because the aspect ratio is a new parameter, there has been no study showing the normal value of the ratio. We would like to perform a study with a large population without blepharoptosis, and to determine the normal value of the aspect ratio and its changes with aging.

A limitation of our study is that we did not analyze the location of the upper eyelid marginal peak. A nasal (medial) shift in the marginal peak has been reported in patients with blepharoptosis [12]. In the field of aesthetic plastic surgery, the marginal peak also has an influence on the attractiveness of the eyes [13]. We would like to analyze the marginal peak in a future study. Another limitation of our present analyses is that all of the measurements were performed by one researcher. We believe that our new parameter is reproducible, but its inter-observer reliability must be examined in a future study.

Conclusions

We performed digital image analysis of patients with blepharoptosis. The aspect ratio of the patients' palpebral fissures (the percentage of the fissure's height to its width) reflected the progression of blepharoptosis and the post-operative changes. The aspect ratio has the potential to be a new parameter of blepharoptosis.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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