



Usefulness of the eyeball exposure area as an eye measurement modality through a comparison between eyes with inborn double eyelids and operated double eyelids

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Background Many Korean women with single eyelids wish to have their eyes enlarged through double eyelidplasty, and many of them also want to have additional procedures in order to have a larger perceived size of their eyes, with the desire for their eyes to resemble those with inborn double eyelids. Thus, in this study, we performed eye measurements and evaluated the usefulness of the eyeball exposure area to differentiate the overall eye size according to the nature of double eyelids (inborn or operated).

Methods This study involved 92 eyes with natural double eyelids (group A) and 76 eyes with only double eyelidplasty (group B). The two groups were compared through measurements of the exposed eyeball area (EEA) and palpebral fissure height (PFH). To compare the usefulness of the EEA for the perceived eye size, the PFH value was also measured by adjusting it to a percentage value.

Results The mean value of the PFH was 9.95 ± 0.67 mm in group A and 8.48 ± 1.04 mm in group B. The adjusted percentage value of the PFH relative to the corneal diameter (11.3 mm) was 88.05% in group A and 75.04% in group B. The EEA was $85.59\% \pm 3.25\%$ in group A and $82.89\% \pm 6.36\%$ in group B. The difference between the two groups was 13.01% in terms of PFH and only 2.7% in terms of EEA.

Conclusions The values of PFH and EEA were higher in group A, but EEA was more useful for evaluating the perceived eye size between the two groups.

Keywords Measures / Eyelids / Analysis

INTRODUCTION

Several anthropometric studies have reported measurements of the

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eyelids of Koreans [1-4], and a previous study showed that the eyes of subjects with inborn double eyelids were larger than those of subjects with single eyelids, both in the vertical and horizontal dimensions [5]. This difference in eye size is thought to be one of the reasons why peoples with single eyelids request three- or four-directional eyelid enlargement surgery, as well as double eyelid surgery.

Therefore, we performed a preliminary study to compare the differences in size between eyes that underwent double eyelid surgery only and those with inborn double eyelids before comparing the efficacy of multi-directional eyelid enlargement surgery in inborn double eyelid eyes.

The dimensions of the eye are usually evaluated using one-di-

dimensional measurements [6,7]. However, multiple parameters, including vertical and horizontal dimensions, are required to compare differences in eye size, and there are difficulties in analyzing changes in the actual size of the eye using only one-dimensional measurements [8].

METHODS

Study participants

For the study of subjects with inborn double eyelids, Korean women without congenital malformations, trauma, or surgery of the eyelids, in their 20s who were attending medical and nursing colleges, were screened for inclusion in this study with approval from the bioethics committee.

For the study of subjects with operated double eyelids, medical information on patients who had only double eyelidplasty was reviewed, and those who, around their 20s, had undergone double eyelidplasty with a three-part incision method, and were followed for more than 6 months were included (Table 1).

The study was approved by our institution's bioethics committee (protocol: IRB CR-20-210). This study conformed to the ethical principles for medical research presented in the Declaration of Helsinki.

Photographic analysis and percentage values

The palpebral fissure height (PFH) was measured in standardized photographs of each subject using the ruler tool in Adobe Photoshop CS3 (Adobe Systems, San Jose, CA, USA), and the measured values of PFH were converted to percentage values based on the corneal diameter.

The EEA was calculated using a Java-based image-processing program (Image J 1.40; National Institutes of Health, Bethesda, MD, USA). The actual EEA was obtained as a percentage by dividing the exposed eyeball area by the theoretical total eyeball area (exposed area of eyeball/theoretically maximal exposed area of eyeball $\times 100$) (Fig. 1) [9].

The differences in percentage values between the PFH and EEA were compared to analyze which parameter was more useful for precisely detecting the ocular size in subjects with inborn double eyelids and in those with operated double eyelids.

To minimize any error caused by size differences in photographs and due to examiner bias, we performed measurements and corrected our findings to match the average corneal diameter (11.3

mm) of Korean women [1].

Statistical analysis

Statistical analysis was performed using SPSS version 19.0 (IBM Corp., Armonk, NY, USA). Differences in values in PFH from one- to two-dimensional numerical values were evaluated and compared the changes of two-dimensional values of EEA. The difference in percentage values between the PFH and EEA (as a two-dimensional measurement) was compared between the two groups (those with inborn double eyelids and those with operated double eyelids) using the independent-sample t-test. P-values less than 0.05 were considered to indicate statistical significance.

RESULTS

The number of subjects with inborn double eyelids was 46, with a mean age of 24.0 ± 4.5 years. The mean values of PFH and EEA were 9.95 ± 0.67 mm and $85.59\% \pm 3.25\%$, respectively. In this group, the percentage of PFH relative to the corneal diameter (11.3 mm) was 88.05% (Fig. 1).

The number of subjects with operated double eyelids was 38, with a mean age of 22.0 ± 5.7 years. The average follow-up period was 16.4 months. The mean values of PFH and EEA were 8.48 ± 1.04 mm and $82.89\% \pm 6.36\%$, respectively. In this group, the percentage of PFH relative to the corneal diameter was 75.04% (Fig. 2).

The difference in percentages between the two groups was 13.01% for PFH and 2.7% for EEA. The values of PFH and EEA in the subjects with inborn double eyelids were higher than those values in the subjects with operated double eyelids, and there were statistically significant differences ($P < 0.05$) (Table 2).

DISCUSSION

Previous studies using one-dimensional measurements of the eye showed that the values of the same parameter had varying ranges

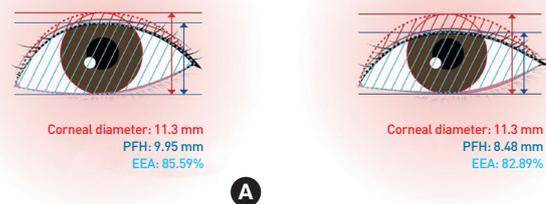


Fig. 1. Schematic drawings of palpebral fissure height (PFH), exposed eyeball area (EEA), and the differences between the parameters. (A) Measured values in inborn double eyelids. (B) Measured values in operated double eyelids.

Table 1. Patients' demographic characteristics

Characteristics	Inborn group (n=46)	Operated group (n=38)
No. of eyelids	92	76
Age [yr], mean \pm SD	24.0 ± 4.5	22.0 ± 5.7
Female sex	46	38

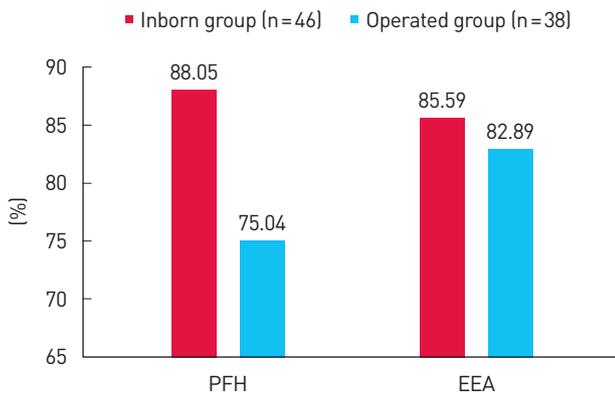


Fig. 2. Differences in measurements between two groups expressed as percentages: the difference was 13.01% for the palpebral fissure height (PFH) and 2.7% for exposed eyeball area (EEA).

according to the number of patients who had double eyelids [4,9-11]. Another study showed different eye sizes between subjects with inborn double eyelids and those with single eyelids in values of one-dimensional measurements such as PFH, palpebral fissure length (PFL), marginal reflex distance 1, and outer canthal distance (OCD) [5].

These differences in eye size are thought to be one of the reasons why people with single eyelids often require medial epicanthoplasty and/or lateral canthoplasty, and/or lowering of the lower eyelid, in addition to double eyelid surgery, when they receive a consultation for eyelid surgery.

Meanwhile, if the PFH is used to measure changes in eye size after double eyelid surgery, it may represent only the change in the distance of the area passing through the center of the pupil because it is a one-dimensional parameter.

In addition, the eye is elliptically shaped, not square, and the vertical height gradually decreases in the rest of the eye as one moves laterally or medially from the center of the pupil [12]. Likewise, using the PFL or OCD or marginal limbal distance to measure changes in eye size after multiple eye-lengthening surgery has same limitation regarding the ability to make accurate assessments of changes in overall eye size following surgery [13].

In other words, it is difficult to perform an accurate assessment of changes in the overall size of the eye after double eyelidplasty or other eye-lengthening surgery if eye measurements are made using one-dimensional parameters.

In the present study, we obtained eye measurements using the PFH and EEA through a digital photographic anthropometric analysis, and compared the results between subjects with inborn double eyelids and subjects with operated double eyelids only. The discrepancy in eye size was compared based on the values of PFH and EEA, which were converted into percentages.

The mean PFH in subjects with inborn double eyelids was 9.95 ± 0.67 mm. This corresponded to a percentage of 88.05% relative to

Table 2. Outcomes in the inborn and operated groups

Outcomes	Inborn group (n=46)	Operated group (n=38)	P-value ^{a)}
PFH (mm)	9.95 ± 0.67	8.48 ± 1.04	<0.05
PFH (%)	88.05 ± 5.93	75.04 ± 9.20	<0.05
EEA (%)	85.59 ± 3.25	82.89 ± 6.36	<0.05

Values are presented as mean \pm SD.

PFH, palpebral fissure height; EEA, exposed eyeball area.

^{a)}Independent-sample t-test.

the average corneal diameter of Korean females (11.3 mm) [1]. In subjects with operated double eyelids, the mean PFH was 8.48 ± 1.04 mm, corresponding to a percentage of 75.04%. The mean values of EEA (itself expressed as a percentage relative to the total theoretically available eyeball area) was $85.59\% \pm 3.25\%$ in subjects with inborn double eyelids and $82.89\% \pm 6.36\%$ in subjects with operated double eyelids.

Therefore, the differences between the two groups in these parameters, expressed as percentages, was 13.01% for the PFH and 2.7% for the EEA, and the differences in the overall size of the eye were represented more closely by EEA than by the PFH.

In a previous study conducting an anthropometric analysis of EEA in Koreans, Park et al. [13] reported that the EEA values differed according to age, and the values of young subjects were higher than those of older individuals: the EEA of those in their teens was $86.84\% \pm 2.92\%$, and that of subjects in their 20s was $82.72\% \pm 4.96\%$.

However, that study did not report the proportion of subjects with double eyelids. The fact that the EEA values found in this study differed to some extent from those reported in previous studies may be due to the inclusion of a different percentage of subjects with double eyelids.

Furthermore, as reported in the previous study, eyes with single eyelids are small not only in terms of PFH, but also in terms of the interpupil distance, OCD, and PFL compared to eyes with inborn double eyelids; therefore, there is a difference in the overall eye size between these two groups.

In double eyelid surgery only, the vertical dimensions increase, but the horizontal dimensions remain unchanged; therefore, the difference in eye size between inborn double eyelids and operated double eyelids is not represented accurately if only differences in vertical dimensions are assessed. Instead, a more accurate method is to include horizontal dimension differences because each one-dimensional parameter represents only its distance.

In this study, statistically significant differences were found for both the PFH and EEA between the two groups. The findings for EEA indicate that the difference in the actual size of the eye between the two groups was 2.7%, not 13.01% because PFH represents only the vertical distance passing through the center of the

pupil, not the actual size of the eye.

This study suggests that EEA is a more accurate parameter than the PFH or other one-dimensional parameters for measuring the actually perceived size of the eye, and that EEA is a useful parameter for comparing changes in the actual size of the eye after multiple eye-lengthening surgical procedures.

A limitation of this study is that even though we attempted to photograph subjects with forehead muscles at rest and attempted to prevent any error caused by size differences of the corneal diameter, the possibility of error caused by the examiner cannot be completely excluded. Furthermore, a study should be conducted to compare the differences between eyes that receive double eyelid-plasty with simultaneous multi-directional eyelid enlargement surgery and eyes with inborn double eyelids to evaluate the efficacy of multi-directional eyelid surgery.

NOTES

Conflict of interest

No potential conflict of interest relevant to this article was reported.

Ethical approval

The study was approved by the Institutional Review Board of Daegu Catholic University Medical Center (IRB No. CR-20-210) and performed in accordance with the principles of the Declaration of Helsinki.

Patient consent

The patients provided written informed consent for the publication.

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