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

INTRODUCTION

Several anthropometric studies have reported measurements of the 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-
imensional 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 × 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-di-mensional 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% ± 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% ± 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

Table 1. Patients’ demographic characteristics

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Inborn group (n = 46)</th>
<th>Operated group (n = 38)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of eyelids</td>
<td>92</td>
<td>76</td>
</tr>
<tr>
<td>Age (yr), mean ± SD</td>
<td>24.0 ± 4.5</td>
<td>22.0 ± 5.7</td>
</tr>
<tr>
<td>Female sex</td>
<td>46</td>
<td>38</td>
</tr>
</tbody>
</table>

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.
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. The difference in eye size between double eyelids and subjects with single 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 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.
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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REFERENCES