

Biometric Study of Eyelid Shape and Dimensions of Different Races with References to Beauty

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Abstract

Background There are few studies that evaluate the differences in the perception of beauty and attractiveness of different races or ethnicities. The purpose of this study was to determine whether there are any actual differences in the configuration of beautiful eyes among different races.

Methods Using seven composite faces of different races or ethnicities, photogrammetric measurements were performed to determine the relative differences in the average and attractive configuration of the eyes. Fourteen distance measurements and five angular measurements were performed for analyzing the morphological differences in the configuration of attractive and average faces.

Results The results of our study found that attractive Korean faces have relatively wide-set eyes and that the medial and lateral eye fissure height is greater than that in average Korean faces. Attractive Korean faces have larger but not ptotic eyes than those in average Korean faces and they have a narrow double fold line; however, attractive Asian faces have a slightly higher double fold line. Attractive Korean or Asian faces do not have an epicanthus and there is a lot of exposure of white in the medial and lateral area of the eyes. Attractive Caucasian and African

faces have an acute or keen shape to the eyes like the jaguar's eye. Attractive Asian faces have a less steep slant of the palpebral fissure compared to that of the average Asian face, but attractive Caucasian and African faces have a steeper palpebral slant than that of average Caucasian and African faces. Attractive Caucasian and African faces have a relatively narrower palpebral fissure height and width than average Caucasian and African faces. Regardless of race, attractive faces have wide-set eyes and a lower brow position than average faces.

Conclusions “Beautiful eyes” can be defined as youthful, brilliant, vivid, and attractive. We found that there are some common and some different characteristics in the configuration of beautiful eyes according to racial background.

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Keywords Beautiful eyes · Beauty Attractiveness · Racial difference · Ethnic difference · Blepharoplasty

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There are many famous immortal quotes on beauty. Vincent Van Gogh said that “if you truly love Nature, you will find beauty everywhere.” Confucius said that “Everything has beauty, but not everyone sees it.” Although it is said that beauty lies in the eyes of beholder, William Shakespeare wrote that the eyes are the windows of the soul. Beautiful eyes play a very important role in the perception of general attractiveness and blepharoplasty is one of the most commonly performed aesthetic plastic surgeries worldwide [1].

What are beautiful eyes? There are some studies that suggest that beautiful faces have universal features but other studies emphasize that perception of attractiveness differs according to race or ethnicity [2–8]. In previous studies we had presented the composite faces of different races and emphasized that a stereotype analysis of beauty should not be performed; we must understand racial and cultural diversity and try to respect the beauty of other human races [9–12]. This current study was performed to demonstrate that beautiful eyes play a very important role in the perception of general facial attractiveness and to assess whether there are any actual differences in the configuration of beautiful eyes among different races.

Materials and Methods

We previously reported a preliminary study of four composite faces of different races or ethnicities using a morphing technique [10, 12]. In the present study, we analyzed the periorbital aesthetic characteristics in attractive or beautiful composite faces of different races and compared them to the characteristics of average composite faces. Prior to performing this study, we prepared two new composite faces using a morphing technique. As Cho [13] and Kim [14] had published examples of average Korean composite faces separately several years ago, we intergrated two composite facial photos into one photo to represent a new average Korean face (Fig. 1, AVK). Since Cho had published the images of beautiful composite female faces in a book [13] and we had published the images of average attractive Korean composite faces in our previous article [12], we prepared another composite face morph representing the new average attractive Korean face by morphing the two composite faces (Fig. 1, ATK). Then we prepared an average Asian attractive face by morphing the previous images of Korean, Japanese, and Chinese attractive faces [10] (Fig. 1, ATA). We acquired images of the average Caucasian composite face (Fig. 1, AVC) and the average African composite face (Fig. 1, AVB) from <http://www.faceresearch.org> (with copyright permission).

We prepared seven composite faces representing an average Korean face, an attractive Korean face, an attractive Asian face, an average Caucasian face, an attractive Caucasian face, an average African face, and an attractive African face (Fig. 1). The periorbital aesthetic configuration or structure was assessed in these seven composite faces. We hypothesized that the interpupillary distance in an average person is almost constant in each race, and each composite face has an average interpupillary distance which reflects the racial characteristics. The relative pixel distance in photography were measured and we acquired the absolute values by arithmetic conversion as performed by the others [15, 16]. We measured the number of pixels and angles between the photographic facial landmarks using ImageScope Viewer (Aperio Technologies, Inc., CA, USA, <http://www.aperio.com/download-imagescope-viewer.asp>) and GIMP2 (Free Software Foundation, Inc., Boston, MA, USA) software. As a reference value, we set the interpupillary distance (IPD) at 63.5, 61.47, and 63.7 mm for Asian, Caucasian, and African faces, respectively, because Kim and Ham [17] had reported that the IPD of average Korean women was 63.5 mm, Barretto and Mathog [18] had reported that the IPD was 61.47 mm in white women, and the IPD for African women was set at 63.7 mm based on the study by Murphy and Laskin [19]. Then the relative pixel distance was measured and was arithmetically transformed into anthropometric data. Photographic facial landmarks were prepared for analyzing the aesthetic configuration of the eyes (Fig. 2). The definitions of each measurement are given in Tables 1 and 2. Composite faces were measured repeatedly and the mean values were recorded in order to determine whether there are any differences in the configuration of periorbital beauty among different races.

Results

A summary of the results of our measurements is given in Table 3.



Fig. 1 Periorbital aesthetic characteristics in average or attractive composite faces from different races. The seven composite faces used in this study were an average Korean face (AVK), an attractive Korean face (ATK), an attractive Asian face (ATA), an average

Caucasian face (AVC), an attractive Caucasian face (ATC), an average African face (AVB), and an attractive African face (ATB). Photographs of AVC and AVB are from <http://faceresearch.org>. Welling et al. [56] details the methods for making these average faces

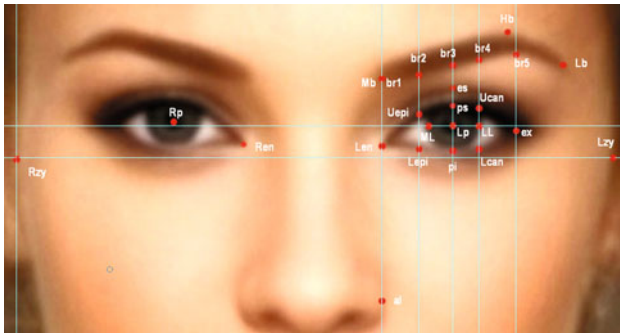


Fig. 2 Landmarks or fiducials for our photogrammetric analysis. Rp, right pupil; Lp, left pupil; ML, most medial point of limbus; LL, most lateral point of limbus; Rzy, right zygion; Lzy, left zygion; en, endocanthion; ex, exocanthion; Ren, right endocanthion; Len, left endocanthion; pi, palpebrae inferius; ps, palpebrae superius; Uepi, midpoint between en and ps; Lepi, midpoint between en and pi; Ucan, midpoint between ps and ex; Lcan, midpoint between pi and ex; es, eyelid sulcus; br1, lowest meeting point of eyebrow to vertical line from en; br2, lowest meeting point of eyebrow to vertical line from Uepi; br3, lowest meeting point of eyebrow to vertical line from ps; br4, lowest meeting point of eyebrow to vertical line from Ucan; br5, lowest meeting point of eyebrow to vertical line from ex; al, most lateral point of alar curvature; Mb, most medial point of eyebrow; Hb, highest point of eyebrow; Lb, most lateral point of eyebrow

Type of Eyes

The type of eyes was analyzed by measuring the ratio of interpupillary distance to face width. The calculated ratio of IPD to face width for an average Korean face was 42.32 % and that for an attractive Korean face was 44.99 %. The calculated ratio of IPD to face width in an attractive Asian face was 45.41 %. The ratio for an average Caucasian face was 44.9 % and for an attractive Caucasian

face it was 46.34 %. For an average African face the ratio was 46.6 % and for an attractive African face it was 48.65 %. This result implies that regardless of race, attractive faces have relatively wide-set eyes compared to average faces from the same race.

Inter-canthal Distance (ICD)

The calculated intercanthal distance (ICD) for an average Korean face was 37.67 mm, for an attractive Korean face it was 35.40 mm, and for an attractive Asian face it was 36.03 mm. The calculated ICD in an average Caucasian face was 31.62 mm and for an attractive Caucasian face it was 31.04 mm. For an average African face the calculated ICD was 32.32 mm and for an attractive African face it was 33.04 mm.

Medial Eye Fissure Height (EFH)

The measured medial EFH for an average Korean face was 4.70 mm, for an attractive Korean face it was 6.31 mm, and for an attractive Asian face it was 6.42 mm. The measured medial EFH for an average Caucasian face was 8.43 mm and for an attractive Caucasian face it was 6.66 mm. For an average African face the measured medial EFH was 7.29 mm and for an attractive African face it was 6.31 mm. These results indicate that an attractive Korean face has a relatively greater medial EFH than an average Korean face. However, contrary to an attractive Asian face, the medial EFH was smaller in an attractive Caucasian and an attractive African face compared to an average Caucasian and African faces.

Table 1 Definitions of linear measurements in our study

Abbreviation	Definition	Fiducial
IPD	Distance between the centers of two pupils	Rp–Lp
ID	Maximum horizontal distance of iris	ML–LL
FW	Widest distance between bilateral cheek bones	Rzy–Lzy
ICD	Distance between the two medial points of canthus	Ren–Ren
Medial EFH	Eye fissure height measured at midpoint of medial eye fissure	Uepi–Lepi
Median EFH	Palpebral fissure height vertically from pupillary center	pi–ps
Lateral EFH	Eye fissure height measured at midpoint of lateral eye fissure	Ucan–Lcan
EFW	Distance between medial canthus and lateral canthus	en–ex
ESH	Distance between ciliary margin and highest double fold line	ps–es
UEH 1	Vertical distance from eyebrow to medial canthus	en–br1
UEH 2	Vertical distance from eyebrow to medial midpoint of upper-eyelid margin	Uepi–br2
UEH 3	Vertical distance from eyebrow to center of upper-eyelid margin	Ps–br3
UEH 4	Vertical distance from eyebrow to lateral midpoint of upper-eyelid margin	Ucan–br4
UEH 5	Vertical distance from eyebrow to lateral canthus	ex–br5

IPD interpupillary distance, ID iris diameter, FW facial width, ICD intercanthal distance, EFH eye fissure height, EFW eye fissure width, ESH eyelid sulcus height, UEH upper-eyelid height. Each abbreviated landmark or fiducial is shown in Fig. 1

Table 2 Definitions of angular measurements

Abbreviation	Definition	Fiducial
LCT	Angle of horizontal inclination of the line from medial and lateral canthus	$\angle_{ex, en, Lcan}$
MCA	Angle of medial half of eye fissure around medial canthus	$\angle_{Uepi, en, Lepi}$
LCA	Angle of lateral half of eye fissure around lateral canthus	$\angle_{Ucan, ex, Lcan}$
NEA	Angle formed by endocanthion, exocanthion, and point of alar curvature	$\angle_{en, al, ex}$
EBA	Acute angle formed by most medial, lateral, and highest points of brow	$\angle_{Mb, Hb, Lb}$

LCT lateral canthal tilt, *MCA* medial canthal angle, *LCA* lateral canthal angle, *NEA* nose-to-eye angle, *EBA* eyebrow angle. Each abbreviated landmark or fiducial is shown in Fig. 1

Table 3 Results of the measurements in our study

Measures	AVK	ATK	ATA	AVC	ATC	AVB	ATB
Distance measures (mm)							
Set of IPD	63.5	63.5	63.5	61.47	61.47	63.7	63.7
ID	11.70	12.21	12.49	11.53	11.65	11.75	11.46
IPD/facial width (%)	42.32	44.99	45.41	44.9	46.34	46.6	48.65
ICD	37.67	35.40	36.03	31.62	31.04	32.32	33.04
Medial EFH	4.70	6.31	6.42	8.43	6.66	7.29	6.31
Median EFH	8.62	10.88	12.49	10.72	10.12	10.81	9.83
Lateral EFH	7.62	8.87	10.35	8.41	8.25	8.58	8.18
EFW	24.81	26.78	28.10	28.94	27.45	31.02	28.58
ESH	0	0.94	2.14	2.99	3.46	5.17	3.04
UEH 1	23.01	18.25	18.91	15.2	13.85	20.56	16.60
UEH 2	16.26	13.07	13.91	10.45	10.12	15.63	13.80
UEH 3	17.20	10.65	11.42	10.72	7.99	15.04	11.69
UEH 4	15.92	12.14	12.49	13.44	10.65	18.22	14.26
UEH 5	20.93	17.73	18.91	18.59	17.57	21.15	19.88
Angular measures (degrees)							
LCT	9.77	8.87	8.64	4.12	7.13	5.39	9.98
MCA	52.95	59.01	60.64	55.96	48.99	49.99	48.65
LCA	57.16	61.22	59.59	64.34	51.72	70.42	54.46
NEA	31.37	33.78	34.59	39.3	37.09	55.03	33.61
EBA	125.76	131.01	129.76	128.79	132.39	131.95	104.25

AVK average Korean face, *ATK* attractive Korean face, *ATA* attractive Asian face, *AVC* average Caucasian face, *ATC* attractive Caucasian face, *AVB* average African face, *ATB* attractive African face, *IPD* interpupillary distance, *ID* iris diameter, *FW* facial width, *ICD* intercanthal distance, *EFW* eye fissure width, *ESH* eyelid sulcus height, *EFH* eye fissure height, *UEH* upper-eyelid height, *LCT* lateral canthal tilt, *MCA* medial canthal angle, *LCA* lateral canthal angle, *NEA* nose-to-eye angle, *EBA* eyebrow angle

Median Eye Fissure Height (EFH; Palpebral Fissure Height)

The median eye fissure height (EFH) for an average Korean face was 8.62 mm, for an attractive Korean face it was 10.88 mm, and for an attractive Asian face it was 12.49 mm. The median EFH for an average Caucasian face was 10.72 mm and for an attractive Caucasian face it was 10.12 mm. For an average African face the median EFH was 10.81 mm and for an attractive African face it was 9.83 mm. These results suggest that attractive Asians have a tendency to have larger and nonptotic eyes than average

Asian faces. On the other hand, the palpebral fissure height in attractive Caucasian and African faces was somewhat smaller than that in average Caucasian and African faces.

Lateral Eye Fissure Height

The lateral EFH for an average Korean face was 7.62 mm, for an attractive Korean face it was 8.87 mm, and for an attractive Asian face it was 10.35 mm. The lateral EFH for an average Caucasian face was 8.41 mm and for an attractive Caucasian face it was 8.25 mm. For an average African face the lateral EFH was 8.58 mm and for an

attractive African face it was 8.18 mm. These results indicate that the lateral EFH in an attractive Asian face was relatively greater than that in an average Korean face. Although the difference was insignificant, the lateral eye fissure height in attractive Caucasian and African faces was relatively narrower than that in the average Caucasian and African faces.

Eye Fissure Width (EFW; Palpebral Fissure Width)

The eye fissure width (EFW) in an average Korean face was 24.81 mm, in an attractive Korean face it was 26.78 mm, and in an attractive Asian face it was 28.10 mm. The EFW in an average Caucasian face was 28.94 mm and in an attractive Caucasian face it was 27.45 mm. In an average African face the EFW was 31.02 mm and in an attractive African face it was 28.58 mm. These results suggest that an attractive Asian face seems to have wider-set eyes than the average Asian face but an attractive African or Caucasian face has a relatively narrower EFW compared to the average African or Caucasian face.

Eyelid Sulcus Height (ESH; in Open Eyes)

The average Korean face had no double-fold or eyelid sulcus. The eyelid sulcus height (ESH) in an attractive Korean face was 0.94 mm and in an attractive Asian face it was 2.14 mm. The ESH in an average Caucasian face was 2.99 mm and in an attractive Caucasian face it was 3.46 mm. In an average African face the ESH was 5.17 mm and in an attractive African face it was 3.04 mm. An attractive Korean face has a narrow double-fold line but an attractive Asian face has a slightly higher double-fold line. An attractive Caucasian face had a somewhat thicker eyelid sulcus than an average Caucasian face, whereas an attractive African face has a relatively thinner eyelid sulcus than an average African face.

Upper Eyelid Height (UEH)

Five different upper eyelid heights (UEH) are summarized in Table 3. Interestingly, regardless of race, the UEH in attractive faces was smaller than that in average faces from the same race, which implies that the eyebrows are lower in attractive faces than in average faces.

Iris Diameters (ID)

Although there was no statistically significant difference in the iris diameters (ID), we found that attractive Korean and Asian faces had a relatively larger iris (12.21 and 12.49 mm, respectively) than the other composite faces.

Lateral Canthal Tilt (LCT; Slant of Palpebral Fissure)

The lateral canthal tilt (LCT) for an average Korean face was 9.77°, for an attractive Korean face it was 8.87°, and for an attractive Asian face it was 8.64°. The LCT for an average Caucasian face was 4.12° and for an attractive Caucasian face it was 7.13°. For an average African face the LCT was 5.39° and in an attractive African face it was 9.98°. The average Korean face has a unique Mongolian slant but the position of lateral canthus is relatively lower in attractive Korean and Asian faces. Interestingly, attractive African and Caucasian faces have a relatively greater LCT than average faces from the same race and attractive African and Caucasian faces have an acute eye shape much like a jaguar's eye.

Medial Canthal Angle (MCA)

The medial canthal angle (MCA) in an average Korean face was 52.95°, in an attractive Korean face it was 59.01°, and in an attractive Asian face it was 60.64°. The MCA in an average Caucasian face was 55.96° and in an attractive Caucasian face it was 48.99°. In an average African face the MCA was 49.99° and in an attractive African face it was 48.65°. These results suggest that an attractive Korean face does not have a Mongolian or epicanthal fold and that there is a lot of exposure of white in the medial area of the eye in attractive Asian faces. On the other hand, attractive Caucasian and African faces have relatively less exposure of white in the medial area of the eye than the average faces from the same race.

Lateral Canthal Angle (LCA)

The lateral canthal angle (LCA) in an average Korean face was 57.16°, in an attractive Korean face it was 61.22°, and in an attractive Asian face it was 59.59°. The LCA in an average Caucasian face was 64.34° and in an attractive Caucasian face it was 51.72°. In an average African face the LCA was 70.42° and in an attractive African face it was 54.46°. Importantly, there may be some racial differences in the concept of beautiful eyes between Asians and Caucasians. Although attractive Asians faces have a relatively higher exposure of white in the lateral area of the eye, we found that because attractive Caucasian and African faces have a relatively acute eye shape, they have less exposure of white in the lateral area of the eye than average Caucasian and African faces.

Nose-to-Eye Angle (NEA)

The nose-to-eye angle (NEA) in an average Korean face was 31.37°, in an attractive Korean face it was 33.78°, and

in an attractive Asian face it was 34.59° . The NEA in an average Caucasian face was 39.3° and in an attractive Caucasian face it was 37.09° . In an average African face the NEA was 55.03° and in an attractive African face it was 33.61° . Attractive Korean and Asian faces have a relatively wide nose-to-eye angle, probably because attractive Korean and Asian faces have a greater eye fissure width. On the other hand, attractive Caucasian and African faces have a relatively narrow NEA than the average Caucasian and African faces.

Eyebrow Angle (EBA)

The eyebrow angle (EBA) in an average Korean face was 125.76° , in an attractive Korean face it was 131.06° , and in an attractive Asian face it was 129.76° . The EBA in an average Caucasian face was 128.79° and in an attractive Caucasian face it was 132.39° . In an average African face the EBA was 131.95° and in an attractive African face it was 104.25° . There was no typical quantitative pattern in the EBA among average or attractive faces regardless of race.

Discussion

We analyzed whether there is a relative difference in the average or attractive face among different races. We have tried to demonstrate the current trends in the configuration of beautiful eyes.

How important is periorbital beauty in relation to overall facial attractiveness? For reference, Rhee et al. had previously performed an experiment with Koreans about the effect of individual aesthetic subunits on the perception of overall facial attractiveness [20]. Independent facial aesthetic subunits such as forehead, eyes, and nose, from three women were studied. Each facial subunit was rated by 164 people (68 men and 96 women, average age = 32.4 ± 9.8 years) Attractive eyes were important and one of the deciding factors in the perception of overall facial attractiveness. The categorical regression test for analyzing which aesthetic subunit was more important in the perception of frontal facial attractiveness demonstrated that the most important individual aesthetic subunit is the configuration of the eyes in the overall attractiveness rating of the frontal face. (The β coefficient of each aesthetic subunit was as follows: eye: 6.956, upper face: 3.456, lower face: 2.660, chin: 0.991, lips: 0.911, forehead: 0.764, nose: 1.741, cheekbones: 1.641; adjusted $R^2 = 0.421$, $F = 6.39$, $P < 0.001$.)

In our study, some questions about the reliability of our photogrammetric measuring method may be raised. Even though each composite facial photo had a different

resolution and size, theoretically speaking there was no problem in measuring an angle between three landmarks. However, it was not possible to measure the absolute length in millimeters between two landmarks in photogrammetry with respect to anthropometry. However, as Nunes et al. [21] demonstrated, there was no significant difference between measurements done manually and those done digitally and concluded that results obtained by photogrammetry of digital images are as reliable as direct measurements. Besides, some questions about our method of photogrammetric measurement in pixels and about the appropriateness of arithmetic conversion of relative values into absolute millimeter values may be raised because we hypothesized that the interpupillary distance is almost constant in each race. However, our photogrammetric method can be verified by the following facts: Because of the morphing method itself, composite faces always have average values of data obtained from many people, and it can be said that composite faces are reflective of the average interpupillary distances in celebrities or ordinary people. We also consider that there is no problem with our method of arithmetic conversion of the relative length of photographic pixels in photography into absolute values because previous anthropometric data of average faces are well matched with our results. In addition, it is a well-known fact that variable facial photographs can be standardized based on IPD to eliminate variation in head distance from the camera, and this photogrammetric method has been adopted in previous articles [15, 16], although we must consider this difference in relation to gender [22]. Although others have reported different results regarding the other facial measurements, except for IPD, there was no significant difference in the IPD. Although human IPD is known to vary with respect to age, gender, and race [23] (examples are available at <http://www.cl.cam.ac.uk/~nad10/pubs/EI5291A-05.pdf>), we consider that the IPD is only one referencing scale because it shows a small range of values within a race. As stated above, facial photographs can be standardized based on average IPD values [15, 16] and it is an easily measurable scale with scarce measurement errors among inspectors. It is not a scale that depends on age: the value gradually increases until 17–19 years of age but then there is no change due to age after that ($p < 0.05$) [24]. In studies on the IPD in Koreans, an almost similar finding was reported. It was reported that the IPD in average Korean women was 63.5 mm [17]. The IPD was reported to be 63.2 and 65.1 mm in studies by Park et al. [17, 25]. Hwang et al. [26] reported that the IPD was 63.5 mm in beautiful women and 63.6 mm in ordinary women, but Cho et al. [27] reported that the IPD was 66.6 mm. When we investigated the results of various anthropometric studies, although we were likely to find a wide variation in the results of the same measurement, we

found that the IPD values were almost consistent or had a very narrow range of variation.

We found a lot of similar findings while comparing our results with those of previous anthropometric studies in Koreans. Regarding the type of eyes, our result implies that regardless of race, attractive faces have relatively wide-set eyes in comparison to average faces of the same race. This phenomenon may be explained by the fact that in general an attractive female face is relatively narrow in comparison to an average face of the same race.

Previous anthropometric studies in Koreans reported that the horizontal dimension or width of the palpebral fissure in average women ranged from 24.17 to 33.4 mm and that in attractive women was 29.93 mm [24–34]. Another report found that the average palpebral fissure width in 49 Chinese females was 26.36 ± 1.4 mm [35]. Patil [36] reported that the mean value for the horizontal dimension of the eyelid was less in men than in women in Indian people, measuring 32.3 ± 2.2 mm vs. 33.7 ± 1.8 mm. Farkas [37] reported a mean value of 31.0 mm in Caucasian adults. Price et al. [38] reported that the palpebral fissure width in African American females (20–39 years old) was 27.0 ± 1.4 mm but it was 27.2 ± 1.8 mm in whites. Meanwhile, Kunjur et al. [39] reported that the palpebral fissure width was 26.5 ± 2.2 mm in white women, 28.2 ± 2.1 mm in Indian women, and 26.8 ± 2.3 mm in Chinese women. Porter and Olson [40] reported that the average eye fissure width in 108 black women was 32.1 ± 0.18 mm but that in North American Caucasians it was 30.7 mm [41]. However, our measurement of the eye fissure width or horizontal dimension of the palpebral fissure was 24.81 mm in an average Korean face and 26.78 mm in an attractive Korean face, 28.10 mm in an attractive Asian face, 28.94 mm in an average Caucasian face and 27.45 mm in an attractive Caucasian face, and 31.02 mm in an average African face and 28.58 mm in an attractive African face. According to the results of our study, we found that an attractive Asian face has a greater eye fissure width than an average Asian face, but an attractive Caucasian or African face has a smaller eye fissure width than an average Caucasian or African face.

Regarding the vertical dimension of the palpebral fissure, Duke-Elder [42] reported that the mean value in the Western population was 9–13 mm. Anthropometry of the eyelid in an Indian population [36] demonstrated that the mean value for the vertical dimension of the eyelid was less in Indian men than in Indian women and measured 11.7 ± 1.6 mm. Price et al. [38] reported that the palpebral fissure height in African American females (20–39 years old) was 9.5 ± 1.4 mm whereas in whites it was 10.3 ± 1.0 mm. Kunjur et al. [39] reported that the palpebral height was 9.8 ± 1.2 mm in white women, 10.7 ± 1.2 mm in Indian women, and 10.6 ± 0.9 mm in Chinese women. In comparison, in studies of Koreans, the

palpebral fissure height for average faces ranged from 7.8 to 12.5 mm and that for beautiful faces ranged from 8.98 to 9.12 mm [29, 34, 43, 44]. In our results, the eye fissure height was 8.62 mm for an average Korean face and 10.88 mm for an attractive Korean face, 12.49 mm for an attractive Asian face, 10.72 mm for an average Caucasian face and 10.12 mm for an attractive Caucasian face, and 10.81 mm for an average African face and 9.83 mm for an attractive African face. These results suggests that an attractive Oriental face has a relatively greater palpebral fissure height than an average Oriental face but attractive African and Caucasian faces have a relatively smaller palpebral fissure height than average African and Caucasian faces.

The slant of the palpebral fissure or lateral canthal tilt measured $8.8 \pm 2.3^\circ$ or 9.5° in average faces and 4.84 – 5.86 degrees in beautiful faces [24, 25]. Kunjur et al. [39] reported that the palpebral axis was $4.0 \pm 2.3^\circ$ in white women, $1.2 \pm 3.4^\circ$ in Indian women, and $5.7 \pm 2.4^\circ$ in Chinese women. The average angle of the palpebral slant in 49 Chinese females was $7.05 \pm 2.28^\circ$ in the right eye and $7.79 \pm 2.59^\circ$ in the left eye [35]. Price et al. [38] reported that the palpebral axis in African American females (20–39 years old) was $6.0 \pm 2.3^\circ$ but that in white women was $5.8 \pm 2.3^\circ$. In our results, the slant of the palpebral fissure was 9.77° in an average Korean face and 8.87° in an attractive Korean face, 8.64° in an attractive Asian face, 4.12° in an average Caucasian face and 7.13° in an attractive Caucasian face, and 5.39° in an average African face and 9.98° in an attractive African face. This result implies that an attractive Oriental face has a less steep slant of the palpebral fissure than an average Oriental face but an attractive Caucasian or African face has a steeper palpebral slant than an average Caucasian or African face.

There is also a wide range in the values for intercanthal distance in different studies. The ICD was 37.4 mm in average women in a Korean study [44], but Hwang et al. [26] reported that the average ICD was 34.0 mm in beautiful women and 36.7 mm in ordinary women. Barretto et al. [18] reported that the ICD for African American and Caucasian women was 34.1 and 32.9 mm, respectively, but the mean ICD value was 32.7 ± 1.5 mm in the Indian population [36]. Kunjur et al. [39] reported that the ICD was 33.3 ± 2.7 mm in white women, 31.1 ± 2.6 mm in Indian women, and 36.4 ± 2.7 mm in Chinese women. Porter and Olson [40] reported that the average ICD in 108 black women was 31.4 ± 0.26 mm. Meanwhile, Farkas [41] reported that the ICD in North American Caucasian women was 31.8 mm. This finding was similar to that of our study because in our study the calculated ICD was 37.67 mm for an average Korean face and 35.40 mm in an attractive Korean face, 36.03 in an attractive Asian face,

31.62 mm in an average Caucasian face and 31.04 mm in an attractive Caucasian face, and 32.32 mm in an average African face and 33.04 mm in an attractive African face. This result implies that an average Asian face has a relatively wider ICD than that in an attractive Asian face but attractive Caucasian and African faces have a much smaller ICD than average Caucasian and African faces.

There are a few anthropometric studies that have evaluated the medial epicanthal fold. Hwang and Seo [45] reported that the epicanthal fold was expected to be present in 14 % of average Asian females and Song et al. [34] reported that its prevalence was 10 % among women in their study. The incidence of a double fold in subjects was 20–35.6 % in males and 20.5–50 % in females in Korea, and the width or height of the double fold ranged from 1.2 to 2.0 mm in average women when in a relaxed forward gaze and in beautiful faces it was 0.92 mm in open eyes [24, 25, 30]. Price et al. [38] reported that the pretarsal skin height or eyelid sulcus height was 3.6 ± 1.6 mm in African American females and 3.3 ± 1.6 mm in white females. This finding is similar to that in our study: the eyelid sulcus height was 0.94 mm in an attractive Korean face, 2.14 mm in an attractive Asian face, 2.99 mm in an average Caucasian face and 3.46 mm in an attractive Caucasian face, and 5.17 mm in an average African face and 3.04 mm in an attractive African face.

With respect to the iris diameter, previous articles reported that the average iris diameter in an average face was 11.3–13.8 mm and that in a beautiful face it was 12.6–13.6 mm [25, 30]. Our study revealed that the iris diameter in an average Korean face was 11.7 mm and attractive Korean and attractive Asian faces have a relatively larger iris (12.21 and 12.49 mm, respectively) than the other composite faces, which can be explained by the fact that attractive Asian celebrities often wear round lenses which usually helps to make women look more childlike.

In our analysis of eyebrows, although we reported there was no typical quantitative difference in the eyebrow shape among average or attractive faces irrespective of race, the height of the upper eyelid in attractive faces was smaller than that in average faces from the same race, which implies that the eyebrows are lower in attractive faces than in average faces and that the absolute distance between eyebrow and eyelid of attractive faces is relatively smaller than that in average faces. Accordingly, we must bear in mind that although the aging process inevitably causes the eyebrows to descend from their original position, if the plastic surgeon lifts the patient's eyebrows to a position that is too high, especially the medial eyebrow, it usually goes against the aesthetics of facial attractiveness.

As has been recently reviewed, because the range in anthropometric measurements is too great, showing

different results from previous anthropometric studies from all over the world, we emphasize that absolute measurement values, such as those in millimeters or centimeters, reported in previous periorbital anthropometric studies may not be the criterion or standard for surgical planning. It is necessary that we individualize our surgical planning or approach to patients and should always take not only age or gender but also racial differences into consideration. Aesthetic plastic surgeons need to understand the relative differences between attractive eyes and average or ugly eyes. Patients want effective and relative enhancement of the periorbital area, regardless of absolute arithmetic and anthropometric data. We believe that surgeons need to analyze the patient's eyes based on both the average and attractive values because beauty configuration and its assessment must be personalized for each patient. Then the aesthetic characteristics of the patients' eyes must be examined after analyzing the patient's own overall harmonized or balanced facial aesthetic configuration, such as facial height or facial width. For example, if someone's facial height is too long, a 9-mm palpebral fissure height may make the eyes appear small but it may make the eyes look big for those who have a short midface. Although we reported the absolute arithmetic values of attractive eyes in this article, the numerical values are not that important and the relative differences or trends in the values of attractive eyes in comparison to those of average eyes are more important because the surgical strategy needs to be personalized accordingly.

Blepharoplasty is one of the most common aesthetic surgeries; what kind of eye shape appears attractive for people? If we observe peoples' behavior, we can draw inferences about what people consider beautiful eyes. Korean people sometimes take facial photos at an angle called the *ulzzang* angle in the Korean language, and means that the camera is 15–30° higher than the photographic subject. This makes the relative size of the subject's eyes appear larger and the lower face appear smaller. Some young Koreans often use glue or tape to make temporary double eyelids or they wear round lenses. If someone has double eyelids and a bigger iris, although it is a perceptual illusion, they appear to be more attractive because the contour of the eyes is better contrasted due to the double-eyelid lines or round lenses. Delicate smoky eye makeup often camouflages unattractive eyes and helps to make the eyes appear well-contrasted, vivid, and bigger. However, this phenomenon is not always popular in Western cultures because many famous attractive female celebrities have relatively sharp, acute eyes similar to those of the jaguar. Caucasians do not seem to want big, round eyes like those of average Caucasians.

Beautiful eyes are not the same as attractive eyes. Although we usually like relatively big eyes in children,

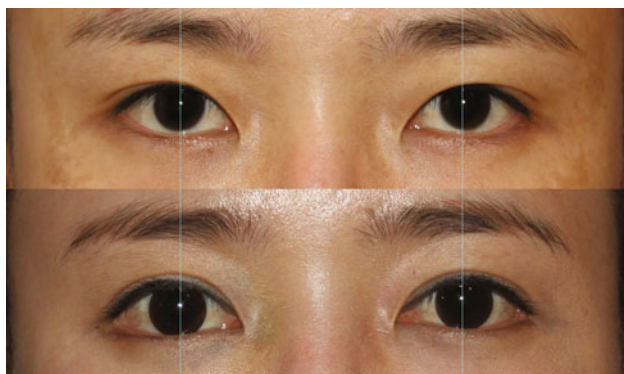


Fig. 3 An example of Asian blepharoplasty. The sharp and keen shape of Caucasian eyes seems to be very attractive in the Caucasian culture but Asian patients usually want to change the shape of the eyes, remove the Mongolian fold or slant, and lengthen or enlarge the palpebral fissure width and/or height by blepharoplasty. Pre- and postoperative (18 months) photographs are provided courtesy of Dr. Bongsik Kwon. A patient underwent a double-eyelid operation, medial epicanthoplasty, and lateral canthoplasty because she wanted to change her eye shape into rounder and bigger eyes. Preoperative photograph shows an acute and keen eye shape, incomplete double fold line, Mongolian fold or epicanthic fold, and excess lateral canthal tilt. Photogrammetric analysis reveals that iris diameter is increased by 11 % because she wears round lens in the postoperative photo. Inter-canthal distance is decreased to 92.8 % of the preoperative eye after medial epicanthoplasty. There are no remarkable changes in medial, median, and lateral eye fissure height after surgery. Eye fissure width is increased by an average of 9.4 %. There is a new complete double fold line. The angle of the lateral canthal tilt changed from 10.4° to 3.7° for right eye and from 8.16° into 4.82° for the left eye. Medial canthal angle decreased from 48.7° to 45.4°. Lateral canthal angle decreased from 70.3° to 59.8° after lateral canthoplasty

they are not considered to be attractive eyes. We must bear in mind that there is no perceptual concept of beauty if we take into account the times, the patient's age, generation, gender, personal preference, and race. In addition, there are important differences between men and women in the perception of attractive eyes. For example, many Korean women do not like thick double eyelids on men for the sake of the traditional physiognomic conception. Sharp and acute eyes of male celebrities seem to be very attractive in Caucasian culture but this cannot be generalized to Asians' aesthetic concept. An example showing different aesthetic concepts of periorbital beauty among races is presented at Fig. 3. We feel that some Caucasian surgeons may disagree with the idea of an Asian aesthetic point of view. However, it must be emphasized that the concept of beauty in Asians is somewhat different from that of Caucasians. In Asia, many new and distinctive surgical techniques for blepharoplasty have been developed to come up to or meet current aesthetic desires of Asian patients. Asian patients want to change the shape of the eyes, remove the Mongolian fold or slant, and lengthen or enlarge the palpebral fissure width and/or height by procedures such as aesthetic medial epicanthoplasty [46–48], lateral canthoplasty [49–51],

lowering the lower eyelid [52], and Muller's muscle surgery for mild ptosis [53–55]. Different concepts about “beautiful eyes” among different races influence our approach to blepharoplasty because some kinds of blepharoplasty techniques are not usually useful or appropriate for Caucasians.

Beautiful eyes can be defined as youthful, brilliant, vivid, and attractive eyes; however, our study revealed that there are some common and some different findings in the concept of beautiful eyes according to different races. The authors emphasize that an aesthetic analysis of an individual patient's eyes must be performed prior to blepharoplasty according to the average and attractive scales or rulers based on the current beauty trend in the same race and not based on the old average anthropometric data.

Conclusions

“Beautiful eyes” can be defined as youthful, brilliant, vivid, and attractive eyes. We found that there are some common and some different trends or anthropometric differences between average and attractive eyes according to racial background.

Conflict of interest None of the authors has a financial interest in any of the products or devices mentioned in this article.

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