Contents lists available at ScienceDirect

Journal of Cranio-Maxillo-Facial Surgery

Female eye attractiveness − Where beauty meets science

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A R T I C L E   I N F O

A B S T R A C T

Introduction: While periorbital and -ocular surgery ranks amongst the most frequently performed plastic surgical procedures, only scarce information exists regarding the contributing factors of aging and its systematic anatomic assessment. The presented study, based on measuring distinct physical landmarks, aimed to gather data to provide a foundation of in-depth periorbital analysis in order to more clearly define female eye attractiveness.

Methods: 80 probands (age range: 30–50 years, M = 38.4 ± 6.5 years) were asked to judge 60 standardized high-resolution digital pictures of female eye regions in respect to the perceived age (in years) and attractiveness (7-point Likert scale). All photographs were objectively evaluated and measured utilizing a total of 38 distinct landmarks. The data was analyzed by calculating correlations between relevant measured eye area parameters and mean attractiveness ratings including age estimations.

Results: Overall, it was found that several specific eye shape features correlate with attractiveness and perceived age. For instance, large visible height of the iris and large upward and lateral inclination of both eye axis and eyebrows correlated moderately to strongly with attractiveness (p < 0.05).

Conclusion: Regarding the female eye, there exist distinct periorbital anatomic features and landmarks which contribute to a youthful appearance and attractiveness. Knowledge regarding these facts may serve as an important guideline for pre- and post-operative patient analysis.

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1. Introduction

The females' face and beauty have been of central importance across cultures throughout history. Already in 3000 BC, women were using primitive makeup to enhance the appearance of their face and especially also their eyes. Likely, the fact that these attributes are so difficult to objectively decipher and measure has challenged artists, philosophers and physicians alike. Much of the

past and present facialmetric research has focused on how to define the complex constituents of the ideal face, while recognizing the importance of individual differences in social perception and attractiveness (Cunningham et al., 1990). Clinical studies conducted under controlled settings, e.g. attractiveness ratings, age estimations etc., seem to have enormous relevance for proper planning of surgical interventions.

The face with its exposed position expresses the elementary human emotions like sympathy or antipathy, anger or pleasure, surprise or sadness, and plays a fundamental role in this regard (Volpe and Ramirez, 2005). Already in infancy, humans recognize emotionally attached persons by their eyes (Robson, 1967). Later in life, the periorbital area impacts general attractiveness and partnership selection (Geary et al., 2004; Gottschall et al., 2008), while skin quality, shape and position of eyebrows, the condition of eye lashes (color, length, shape), eye shape, -axis and eyelid fissure

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height have been found to be of importance (Korczyn et al., 1976; Pressman et al., 1986; Romm, 1989; Fagien, 2002; Schreiber et al., 2005; Grundl et al., 2008).

Based on these facts, scientists have attempted to specify the anatomic landmarks which most significantly contribute to ideal facial proportions (Mommaerts and Moerenhout, 2011; Milutinovic et al., 2014) and symmetry (Springer et al., 2007). In these evaluations, most authors focused on only one periorbital feature, like Schreiber et al., who investigated the dimensions of aesthetically pleasing eyebrows (Schreiber et al., 2005). They measured and analyzed the distances between the medial canthus to the medial eyebrow, the lateral limbus to the lateral eyebrow, and the eyebrow arch position in correlation to the eye width, but they did not incorporate other periorbital features. Ultimately, the authors concluded that there exist different perceptions of "ideal proportions" between the general public and plastic surgeons (Schreiber et al., 2005).

Fagien concentrated his analysis of facial beauty mostly on the upper periorbital region, and discusses his findings in the surgical context of upper lid blepharoplasty (Fagien, 2002), pointing out the importance of a low upper eyelid crease in combination with volume preservation in order to achieve a youthful appearance (Fagien, 2002). Of interest, also the pupils and their respective size are of importance. Korczyn et al. analyzed pupillary diameters in relation to the ocular sympathetic system in young and old subjects and showed that sympathetic tone is increased in younger ages (Korczyn et al., 1976). The larger pupillary diameter might thus be interpreted as a sign of youthfulness.

Other authors have described correlations between eye form and perceived age (Jelks and Jelks, 1993; Fagien, 2002; Rohrich et al., 2004); the youthful eye is apparently characterized by a long narrow palpebral fissure or an "almond-shaped" eye form. Similarly, Yaremchuk reported that the aging process can cause a descent of the lower lid margin and a medial migration of the lateral canthus, resulting in a rounding of the palpebral fissure, creating a round, older appearing form of the eye (Yaremchuk, 2004). However, analyzing only specific features qualitatively makes it difficult to draw general conclusions about periorbital attractiveness.

The aim of the presented study was thus to evaluate the periorbital area in its entirety, the hypothesis being that there exist certain features and anatomic landmarks which are perceived as youthful and attractive across a wide range of subjects and examiners. Foundation of the study was a systematic, reliable and reproducible acquisition of periorbital anantomic data points.

2. Material and methods

2.1. Participants

60 standardized high-resolution images of female periorbital regions were presented to a total of 80 evaluators (N = 80; 40 males, 40 females). The participants were asked to estimate the age of each of the presented persons and to judge the perceived attractiveness according to a Likert scale. The ages of the participants ranged between 30 and 50 years (M = 38.4 ± 6.5 years). This range was selected because persons of this age belong to the main target group for surgical interventions in the eye area. The participants were recruited in a shopping mall, in a cafeteria of a hospital and in a pedestrian area to reveal an unbiased sample which is representative for the general German population. Participation in the study was voluntary and unpaid.

2.2. Stimulus material

The stimulus material was comprised of facial photographs of 60 women ranging from 15 to 65 years of age (M = 39.4, ±15.4 years). The women were — as well as the participants who rated the stimuli — recruited from the general public. A condition for participation was that there was no history of eye diseases. The women were divided into five age categories: 15–24 years, 25–34, 35–44, 45–54 and 55–64 years. Within the youngest and oldest age class, there were 15 women, within the other age classes there were 10 women each. The pictures were taken under highly standardized conditions (straight head position, neutral facial expression, fixed position of camera, and lightning conditions of a professional photo studio). The periorbital area (the tissues surrounding or lining the orbit of the eye with the eyebrows included) was cropped to equal size from a photo of the entire face, and was taken using a resolution of 1024 × 768 pixels. Each photo was then printed on regular photographic paper of 9 × 13 cm, resulting in an image resembling an approximate 1:1 size of the respective eye region.

2.3. Picture evaluation

The photos were presented to the participants in random fashion. The order of the images was rearranged after 50% of the interviews to avoid bias. There was no time limitation to view the images. First, all participants were asked to estimate the age of the photographed person, followed by rating the attractiveness of the presented eye area using a 7-point-Likert-scale (1 = very unattractive, 7 = very attractive).

2.4. Periorbital measurements

In order to measure the periorbital area reliably and precisely, the technique of a coordinate system was developed. All landmarks were assigned to one of five distinct points and incorporated into the analysis (Fig. 1):

1. upper eyebrow border (*ue*)
2. lower eyebrow border (*le*)
3. upper palpebral sulcus (*us*)
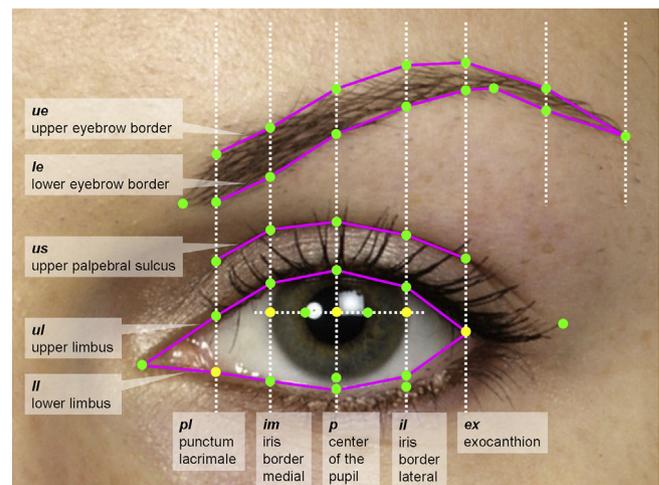4. upper limbus (*ul*)
5. lower limbus (*ll*)

Fig. 1. Eye with contours and reference lines. Vertical reference lines defined by the yellow marked landmarks.

These landmarks are located on one of five vertical reference lines, as defined by the following points which are marked yellow (Fig. 1):

1. punctum lacrimale (*pl*)
2. medial iris border (*im*)
3. center of the pupil (*p*)
4. lateral iris border (*il*)
5. exocanthion (*ex*)

The description of each landmark derives systematically from its position. The first two letters stem from one of the first five anatomic positions, the last two from the location on the vertical reference line. For instance, "*leim*" refers to the position on the lower eyebrow border, in conjunction with the reference line defined by the medial iris border.

Additional reference points include: endocanthion (*en*), medial and lateral end of the eyebrow (*em and el*), the borders of the pupil (*pm and pl*), orbitale superius (*os*, the highest point on the lower eyebrow border), the most lateral point of the cilia (*ci*), the root of the cilia at the lateral iris border, and two additional points on the upper and lower eyebrow border in the middle, between *leex* and *el* (Fig. 2). Table 1 shows all measured reference points (38 items).

All reference points were measured with the help of a digital software program, which was designed by the authors. By selecting relevant image points, the corresponding picture coordinates were automatically recognized, calculated and saved. Afterwards, the respective variables were evaluated using the raw data:

- distances, e.g. eye width, *en-ex*;
- ratio of distances, e.g. eye width divided through eye height, *r(ex-en: ulp-llp)*;
- inclinations (in percent), e.g. inclination of the eye axis, *m(en, ex)*;
- angles (in degrees), namely the lateral eye angle *a(ulil, ex, llil)*.

All single distances were normalized to the horizontal iris diameter (*im-il*).

2.5. Statistical analysis

Statistical analysis included three variables.

- the actual age of the person of whom the picture of the eye area was taken;
- the mean perceived age of the eye area as estimated by the participants;
- the mean assessed attractiveness of the eye area as rated by the participants.

Every measured single variable of the eye area was analyzed to determine its correlation with the three variables. The data were statistically analyzed using SPSS software (IBM, IBM SPSS Statistics 24).

3. Results

The results revealed a strong correlation between the item "attractiveness" of the rated eye area and the stimulus person's age (r = −.87). The most attractive rated 15% of all eye areas belonged to stimulus persons with a mean age of 21.7 years, whereas the stimulus persons with the 15% of the least attractive rated eye areas had an average age of 58.9 years. The participants were also asked to estimate the stimulus person's age; the correlation between mean assessed age and real age was very strong (r = .98).
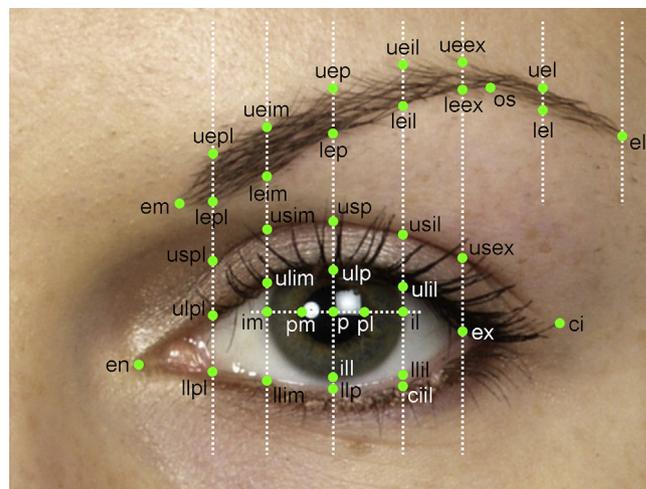

Fig. 2. Eye with additional landmarks.

Table 1
Names and descriptions of the measured reference points.

Upper eyebrow border	
uepl	upper eyebrow border at punctum lacrimale
ueim	upper eyebrow border at iris border medial
uep	upper eyebrow border at center of pupil
ueil	upper eyebrow border at iris border lateral
ueex	upper eyebrow border at exocanthion
uel	upper eyebrow border lateral
Lower eyebrow border	
lepl	lower eyebrow border at punctum lacrimale
leim	lower eyebrow border at iris border medial
lep	lower eyebrow border at center of pupil
leil	lower eyebrow border at iris border lateral
leex	lower eyebrow border at exocanthion
os	orbitale superius
lel	lower eyebrow border lateral
Upper palpebral sulcus	
uspl	upper palpebral sulcus at punctum lacrimale
usim	upper palpebral sulcus at iris border medial
usp	upper palpebral sulcus at center of pupil
usil	upper palpebral sulcus at iris border lateral
usex	upper palpebral sulcus at exocanthion
Upper limbus	
ulpl	upper limbus at punctum lacrimale
ulim	upper limbus at iris border medial
ulp	upper limbus at center of pupil
ulil	upper limbus at iris border lateral
Lower limbus	
llpl	lower limbus at punctum lacrimale
llim	lower limbus at iris border medial
llp	lower limbus at center of pupil
llil	lower limbus at iris border lateral
Pupil	
pm	pupil border medial
p	center of the pupil
pl	pupil border lateral
Iris	
im	iris border medial
ill	iris border at lower limbus
il	iris border lateral
Other reference points	
en	endocanthion
ex	exocanthion
em	beginning of eyebrow medial
el	end of eyebrow lateral
ci	most lateral point of cilia
ciil	root of cilia at iris border lateral

Further, large visible height of the iris and large upward and lateral inclination of both eye axis and eyebrows correlated moderately to strongly with attractiveness. Parameters leading to low age estimations also resulted in high attractiveness ratings. All details are summarized in Table 2. The last three columns of Table 2 contain the mean values of the concerning parameters. The second column from the right lists the mean measurements over the whole sample. For comparison, the third column from the right shows the measurements of the 15% most attractive rated eye areas (N = 9), the first column from the right the measurements of the 15% least attractive eye areas (N = 9).

4. Discussion

Given the multiple factors influencing behavior and aesthetic perception, the authors investigated the question of which peri-orbital features and mosaics induce the judgment "attractive" in female eyes.

Despite the large amount of data, the conclusions of the study can be summarized as follows: an eye area is considered as being "attractive" if it shows features which are typical for youth and younger ages (Fig. 3). Contrarily, it is judged less- or "unattractive", when the eye shows characteristic features of aging (Fig. 4).

4.1. This exemplifies

1. the high correlation between rated attractiveness of an eye area and its perceived age and
2. the high correlation of the coefficients of the item "attractive-ness" or age, respectively, with the other measured physical landmarks.

The verified age-related differences seem very plausible, thus corresponding with the typical aging-processes of the eye and skin. This data demonstrates that these characteristic changes of an eye may be scientifically explained to some extent.

We compared the mean measurements of the 15% most appealing eye areas (mean age 21.7 years) with the 15% least-attractive rated eye areas (mean age 58.9 years).

4.2. Shape of the eye

A crucial point for attractiveness is an open eye. Due to a higher grade of elasticity of the skin and connective tissues, the visible iris height (ulp-llp) is 9.5% larger in younger eyes (81.8% of iris width) compared to older probands (72.3%; p < .01). This may be due to the fact that a higher laxity of the upper limbus-forming tissue in older persons is reducing the visible height of the upper half of the iris.

The initially mentioned hypothesis that a long, narrow palpebral fissure or an "almond-shaped" eye is a typical characteristic of youth and attractiveness, has not been supported by our results. The more the visible parts of the eye resemble an almond-shape ($r(ex$-$en: ulp$-$llp)$), the older (r = .44, p < .01) and less attractive the person was perceived (r = −.42, p < .01). Of course, a senile ectropium leads to a larger degree of the open eye as well, but this is an exception that plays only a marginal role in the total population over all age ranges. This underlines the fact that landmark measurements and respective perceptions can only, if at all, be obtained in healthy individuals without pathologic findings in their eye region. Furthermore, as Rhee et al. have shown, perception of the eyes' beauty is ethnicity dependent: In contrast with many Asians, Caucasians do not seem to prefer big, round eyes which is in accordance with our findings (Rhee et al., 2012).

Nevertheless, the age-related descent of the lower limbus can be clearly validated. This is true for both the medial lower limbus ($m(llpl, llp)$) and the lateral lower limbus ($m(llp, ex)$), r = −.53 respectively r = −.59, p < .01). The measured difference between young and aged eyes is largely differing in up to two standard deviations. The same is true for the increase of the lateral eye-angle. This supports that a canthoplasty or canthopexy for elevation of the lower limbus can potentially be recommended in certain clinical situations such as age-induced alterations with the surgical aim to both prevent ectropion formation and aesthetic improvement.

A significant correlation with age has been found regarding the distance between sclera and ciliary root at landmark $llil$ (r = .72). This distance among attractive eyes (6.74 %) was only half as much as among unattractive eyes (13.01 %, p < .01). This finding also seems to be a consequence of a senile ectropium with an age-related laxity of ligaments and the tarsus.

The lateral eye angle ($ulil,ex,llil$) is also correlated with attractiveness and youth. The larger the angle the more attractive is the eye (r = .34, p < .01).

Surgeons should concentrate their attention on the visibility of the upper half of the iris by generously considering a pexy of periocular ligaments or repositioning of the musculus levator palpebrae. Also, in lower eyelid surgery, canthopexy procedures should be considered, but caution needs to be exerted to avoid narrowing of the lateral eye angle. In summary, it is important to not reduce the degree of eye aperture. An inclination of the eye axis of about 13% should be aimed for. This is in accordance to previous studies reporting on the Jaguar-like upward slanting of the lower eyelid, which positively influences the perception beauty (Grundl et al., 2008; Rhee et al., 2012; Sforza et al., 2015).

4.3. Upper eyelid

The cranially visible iris height (ulp-p) is larger among "attractive" rated eyes (31.67 %) compared to "unattractive" eyes (25.03%; difference 6.6%; p < .01) - probably due to a ptosis-like appearance induced by loss of levator palpebrae muscle tone. The total opening of the eye (ulp-llp) was also larger among attractive eyes (81.8% of iris width) than among unattractive eyes (72.3%, difference 9.5%); p < .01. We assume that this constitutes another characteristic of human aging, since the visible height of the upper half of the iris is reduced in older persons given the upper limbus laxity. Guyuron et al. have described the association between senescence-related enophthalmos and eyelid ptosis (Guyuron and Harvey, 2016). This is in accordance with the findings of Benslimane et al. who recently analyzed the aesthetic characteristics of a females' gaze using anthropometry, and developed an artistic model for gaze evaluation named the "The Frame Concept." (Benslimane et al., 2017) The upper eyelid crease becomes higher, resulting in an elongated and hollowed upper eyelid area as ptosis secondary to levator dehiscence evolves. The authors concluded that the first surgical goal to achieve an attractive result might be to think in terms of frame narrowing by ptosis repair when needed, and volume enhancement of the upper and lower eyelid with or without limited skin resection (Benslimane et al., 2017).

The height of the medial or lateral upper palpebral sulcus allows no conclusions regarding the items eye area attractiveness or perceived age. However, the distance homogeneity between upper palpebral sulcus and upper limbus (|($usim$-$ulim$) - ($usil$-$ulil$)|) represents a criterion for attractiveness (i.e. the more homogeneous, the more attractive, r = −.28, for age r = .21, n.s.). This result has consequences for the surgical removal of excessive skin in an upper eyelid lift. It should be paid attention to achieving the result of a new lidfold, with a homogenous distance to the upper limbus after resection of skin and muscle. Coleman already showed that

Table 2
Correlation between measured features of an eye area and its attractiveness, real age and perceived age. The last three columns list the mean measurement of all eyes and the mean measurements of the extreme groups of most attractive respectively most unattractive eye areas (standard deviations in brackets).

Variable	Description	Unit	Correlation with attractiveness	Correlation with real age	Correlation with perceived age	Mean measurement of the 15% most attractive eyes (SD)	Mean measurement of all eyes (SD)	Mean measurement of the 15% most unattractive eyes (SD)
Attractiveness	attractiveness of eye area (range: 1–7 points)	points		−.87**	−.91**	5.02 (0.39)	3.24 (1.19)	1.69 (0.18)
real age	stimulus person's real age [years]	years	−.87**		.98**	21.67 (4.44)	39.38 (15.41)	58.89 (5.49)
perceived age	stimulus person's perceived age [years]	years	−.91**	.98**		24.28 (3.94)	44.17 (16.38)	67.52 (2.36)
Eye shape								
ulp-ill	visible height of iris (total)	% of iris width	.43**	−.39**	−.39**	80.77 (8.91)	77.29 (8.59)	72.33 (6.97)
ulp-p	visible height of iris (upper half)	% of iris width	.41**	−.33**	−.34**	31.67 (5.09)	29.38 (7.25)	25.03 (8.39)
p-ill	visible height of iris (lower half)	% of iris width	.19 (ns)	−.24 (ns)	−.23 (ns)	49.10 (4.63)	47.92 (3.88)	47.30 (3.45)
r(p-llp: il-p)	visibility of lower iris area	(ratio)	.24 (ns)	−.31*	−.31*	0.99 (0.11)	0.96 (0.10)	0.91 (0.06)
pl-pm	pupil diameter	% of iris width	.61**	−.68**	−.67**	41.70 (5.23)	35.95 (6.20)	31.03 (3.07)
ex-en	eye width	% of iris width	−.13 (ns)	.20 (ns)	.16 (ns)	328.32 (29.61)	340.47 (22.18)	340.71 (18.76)
ulp-llp	eye height	% of iris width	.41**	−.40**	−.40**	81.83 (9.99)	78.70 (9.17)	72.33 (6.97)
r(ex-en: ulp-llp)	almond-shape of eye	(ratio)	−.42**	.44**	.42**	4.05 (0.51)	4.39 (0.64)	4.76 (0.64)
a(ulil, ex, llil)	lateral eye angle [°]	angle in °	.34**	−.29*	−.29*	68.35 (7.43)	64.20 (7.39)	63.05 (5.57)
m(en, ex)	inclination of eye axis [%]	increase in %	.64**	−.61**	−.64**	13.03 (4.15)	7.89 (4.98)	2.65 (5.43)
m(llpl, llp)	inclination of medial lower limbus [%]	increase in %	.57**	−.53**	−.57**	−12.07 (5.93)	−19.26 (7.35)	−26.76 (7.69)
m(llp, ex)	inclination of lateral lower limbus [%]	increase in %	.54**	−.59**	−.60**	40.34 (6.83)	35.38 (7.94)	28.62 (5.53)
llil-ciil	distance sclera - root of cilia @llil	% of iris width	−.73**	.72**	.71**	6.74 (2.85)	9.88 (3.05)	13.01 (2.29)
ci-ex	length of cilia @exocanthion	% of iris width	.69**	−.69**	−.69**	60.18 (13.32)	42.15 (20.86)	26.53 (13.51)
usim-ulim	height of medial upper palpebral sulcus	% of iris width	−.17 (ns)	.09 (ns)	.13 (ns)	26.09 (7.85)	34.11 (16.97)	38.83 (31.86)
usil-ulil	height of lateral upper palpebral sulcus	% of iris width	−.08 (ns)	.01 (ns)	.04 (ns)	24.22 (9.90)	29.25 (15.63)	33.52 (23.69)
|(usim-ulim) - (usil-ulil)|	homogeneity of upper limbus (modulus)	% of iris width	−.28**	.21 (ns)	.26**	6.75 (2.74)	7.63 (5.43)	11.25 (8.37)
Eyebrow								
lepl-ulpl	distance eyebrow - upper limbus @punctum lacrimale	% of iris width	−.18 (ns)	.13 (ns)	.15 (ns)	91.07 (19.94)	96.89 (25.43)	108.71 (26.56)
lep-ulp	distance eyebrow - upper limbus @pupil	% of iris width	−.01 (ns)	.00 (ns)	.01 (ns)	92.71 (22.78)	90.45 (30.31)	95.25 (40.64)
leex-ex	distance eyebrow - upper limbus @exocanthion	% of iris width	.17 (ns)	−.18 (ns)	−.15 (ns)	150.23 (25.81)	137.30 (32.84)	141.54 (37.82)
lel-ex	vertical distance eyebrow @lel - exocanthion	% of iris width	.36**	−.35**	−.34**	139.77 (22.41)	117.48 (33.06)	108.85 (36.84)
p-em	horizontal distance pupil - medial begin of eyebrow	% of iris width	−.34**	.38**	.36**	124.36 (18.85)	151.06 (29.38)	165.70 (16.55)
m(all eyebrow landmarks)	inclination of eyebrow (regression line over all eyebrow landmarks) [%]	increase in %	.60**	−.57**	−.58**	10.13 (5.92)	−1.43 (10.88)	−9.47 (11.31)
m(lepl, leex)	inclination of eyebrow from lepl to leex [%]	increase in %	.54**	−.50**	−.50**	26.73 (9.20)	13.74 (13.49)	7.44 (14.87)
m(lepl, lep)	inclination of eyebrow (medial section) [%]	increase in %	.42**	−.33**	−.36**	39.69 (13.39)	26.43 (18.47)	14.87 (21.35)
m(lep, leex)	inclination of eyebrow (middle section) [%]	increase in %	.43**	−.47**	−.44**	16.09 (10.31)	3.67 (15.91)	0.81 (24.82)
m(leex, lel)	inclination of eyebrow (lateral section) [%]	increase in %	.42**	−.34**	−.40**	−18.98 (10.94)	−32.90 (22.67)	−54.72 (24.32)
ueim-leim	medial thickness of eyebrow	% of iris width	−.26*	.30*	.28*	40.47 (8.98)	55.39 (17.43)	62.43 (20.51)
uel-lel	lateral thickness of eyebrow	% of iris width	−.41**	.46**	.44**	25.44 (10.63)	42.72 (25.28)	58.57 (35.45)
r(uel-lel: ueim-leim)	reduction of eyebrow thickness from medial to lateral	(ratio)	−.35**	.39**	.38**	0.64 (0.22)	0.75 (0.32)	0.93 (0.44)

* = p < .05.
** = p < .01.

Fig. 3. Picture of an eye from a 24 years old female model.

Fig. 4. Picture of an eye from a 68 years old female model.

addressing the additive component of aging (skin excess), while ignoring the substractive component (fat atrophy and volume loss), might lead to a less youthful and less attractive appearance (Coleman, 2006). Several other authors have also defined a youthful attractive upper eyelid as full and convex (Berman, 2000; Little, 2000; Lee et al., 2001; Fagien, 2002; Trepsat, 2003; Rohrich et al., 2004; Coleman, 2006; Gulyas, 2006; Lambros, 2007, 2009; Ciuci and Obagi, 2008; Liew and Nguyen, 2011; Buckingham et al., 2015).

4.4. Eyebrow

Similar to the distance of the upper palpebral sulcus, the distance of the eyebrow to the upper limbus does not seem to be of perceptive importance. Merely, the (vertical) distance of the lateral eye area to the lateral eye angle (*lel-ex*) correlates with attractiveness (r = .36, p < .01) and perceived age (r = −.35, p < .01), as the lateral end of the eyebrow drops in older persons due to progressive loss of elasticity of the collagen fibres.

Very clear are the results of the eyebrow inclination: the higher the eyebrow inclination (*m*(*all eyebrow landmarks*)), the more attractive and younger an eye (r = .60 respectively r = −.57, p < .01) is perceived. The most attractive-rated eyes revealed a positive inclination (10.1%), and the least attractive eyes even a negative inclination (−9.5%). This correlation applies for all three measured sections of the eyebrow, the medial section, the middle section and the lateral section.

In attractive eyes, the medial origin of the eyebrow (measured through *p-em*) is located more laterally (r = −.34, p < .01). In addition, attractive female eyebrows are thinner than in the medial area (r = −.26, p < .05), and particularly in the lateral area (r = −.41, p < .01). These findings should not be over-interpreted, however.

The correlations between eyelash length (ci-ex) and age (r = .−69 respectively .69, p < .01) were also strong. The measured length of the eyelashes in young females is more than twice the length measured in women of older age. The measured differences accounted for more than two standard deviations.

Also the length of cilia and the density and distribution of brow hairs must be taken into consideration, as the length of the cilia (*ci-ex*) correlates highly with attractiveness. Long and dense eyelashes are a noticeable physical attribute, being considered as "typically" feminine. The market for mascara, artificial eyelashes and extensions underscores this fact.

Just as important as the length of the cilia is the distance between sclera and root of the eyelashes (*llil-ciil*), correlating highly with the perceived age of a person.

Schreiber and colleagues evaluated the dimensions of an aesthetically pleasing eyebrow by using 27 different photographs and concluded that the judgment of attractiveness differs between plastic surgeons and the general public. Given that patients usually wish to become more attractive by their own standards, which are often the common held standards, Schreiber et al. stress the importance of defining and respecting the opinions of the general public and to incorporate that knowledge into the peri-operative planning phase (Schreiber et al., 2005).

In previous studies, Gründl et al. (Grundl et al., 2008) and Feser et al. (2007) showed, what important role the eye axis and eyebrows play in the attractiveness of a human's face. Younger people (<30 years of age) preferred low eyebrows and a gently oblique and ascending eye axis, while older persons preferred more arched eyebrows. These are parameters that can be modified with plastic-aesthetic surgery (Flowers and Flowers, 1993; Ramirez, 1994, 1997; Fagien, 1999, 2002; Knize, 2001; Rohrich et al., 2004). Gründl et al. also analyzed features which cannot be changed surgically, and showed that a large pupil diameter and a bright sclera positively correlate with "attractiveness" and youthfulness whereas iridal color (e. g. blue eyes) does not play a major role in aesthetic perceptions (Grundl et al., 2012). Sforza et el. showed similar results when analyzing three-dimensional computerized images of more than 300 attractive subjects during beauty contests. The authors concluded that a larger/wider soft tissue orbital area and faces with a juvenile appearance are preferred (Sforza et al., 2015), which goes in line with the babyfaceness hypothesis of facial attractiveness (Bashour, 2006).

Despite all found correlations between the measurements, attractiveness and age, it must be kept in mind that it is generally not possible to conclude from correlation to causation. In addition, the abstract item "attractiveness" needs to be evaluated by a representative sample of the population. In the presented study, the sample of participants was representative for the German population. Further, only female periorbial regions were evaluated, which is a limiting factor of the study. Also skin quality influences perception of age. Unfortunately, unlike landmarks, skin quality is hard to measure numerically. In the end, attractiveness is composed of a combination of skin quality and the analyzed landmarks. It is important to note that the results of the study cannot be generalized over different nations, cultures or ethnic groups, because ultimately beauty lies in the eye of the beholder,

and attractiveness is influenced by a plethora of individual and external sociodemographic factors (Rhee et al., 2012; Broer et al., 2014; Heidekrueger et al., 2017) strongly correlating with individual preferences (Romm, 1989; Schreiber et al., 2005; Volpe and Ramirez, 2005; Feser et al., 2007; Borelli and Berneburg, 2010).

5. Conclusions

This study was performed to gather comprehensive data to aid with an in-depth pre- and post-operative operative analysis. Not only was it possible to verify age-related anatomic changes of the periorbital area, but the study elucidated distinct criteria which significantly contribute to facial attractiveness. The according factors were quantified, and their effect on attractiveness empirically examined. The findings may serve as reliable guidelines for pre-operative analysis, as they more clearly define standard values of certain age groups. Further, operative goals become more distinct in terms of the sought for most attractive, i.e. "ideal" eye.

Conflicts of interest

None.

Funding

None.

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