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Anthropometric Analysis of the Upper Eyelid and Eyebrow in Patients Attended by the Plastic and Reconstructive Surgery Service of the Hospital Central Sur De Petróleos Mexicanos

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Abstract

Upper eyelid blepharoplasty is one of the most frequently performed surgeries by plastic surgeons worldwide. A prospective observational study was conducted to describe the anthropometric measurements of the upper eyelid and eyebrow in a Mexican population. The researcher measured the anthropometry of the eyelids and eyebrows to establish the diagnosis and surgical plan according to the checklist created and applied by the plastic and reconstructive surgery service. In anatomical position with a caliper instrument, the marginal reflex distance (MRD1), the tarsal thickness, the length of the vertical and horizontal slit, and finally the distance at which the external canthus is located with respect to the internal canthus were measured in millimeters. For the anthropometry of the eyebrows, the distance from the eyebrows to the hairline, the position in millimeters of the orbital rim with respect to the eyebrow, and the angle of its apex were measured. A sample of 210 patients was obtained, of which 65 were male and 145 females, divided by age groups. It was observed that in the three age groups, females presented a vertical palpebral fissure with a higher mean than males. Similar is the case of tarsal thickness, in which the difference was significantly greater in the female of the three age groups. On the other hand, it was observed that the horizontal slit in males was higher than that of females, while the MDR1 was similar in both sexes. Finally, it was identified that in the group of 41 to 50 years old significant decreases are observed both in the vertical cleft, tarsal thickness

and the position of the external canthus compared to the group of 20 to 30 years old, this is due to the aging process. When evaluating the anthropometrics of the eyebrows, a greater distance from the trichion to the eyebrow was observed in males than in females, in contrast to the position of the eyebrow with respect to the supraorbital rim and its apex, in which it was shown that in females there is a greater distance. In the other groups, the trends were maintained; however, a decrease was observed in the angle of the apex of the eyebrow and the RSO-eyebrow distance in males and females with advancing age, being more important in the group of 41 to 50 years. Systematized palpebral and periorbital anthropometric analysis is fundamental in the evaluation consultation. It allows us to make a precise diagnosis of the functional and aesthetic alterations that must be corrected during a surgical procedure, according to the concept of beauty of each culture or ethnicity.

Keywords

Eyelid, Upper-Eyelid, Eyebrow, Anthropometrics, Facial-Analysis

1. Introduction

Upper eyelid blepharoplasty is one of the most frequent aesthetic surgeries worldwide, the International Society of Aesthetic Plastic Surgery (ISAPS), in its "Surgery survey 2020", ranked third in frequency among procedures performed by plastic surgeons, only surpassed by liposuction and breast augmentation. In Mexico, this procedure was performed in more than 40,000 patients during that year, with a functional indication in 70% of cases and an aesthetic indication in the remaining 30%. In addition, it was reported that blepharoplasty was performed more frequently in females (up to 80%) between 50 and 75 years of age [1].

There are various techniques and surgical approaches to perform a blepharoplasty, in many cases applied according to the criteria of each plastic surgeon which is essentially influenced by their training, the population with which they were trained and the ethnic concept of facial and periorbital aesthetics. However, despite the surgical variants that exist and current technologies, there is a lack of solid scientific evidence that provides us with safety points that improve postoperative results, reduce trans and postoperative complications, and finally, improve patient satisfaction [2] [3].

Within current trends in periorbital rejuvenation surgery research, there are studies in which the objective is to improve preoperative marking since without a reproducible, effective and simple marking technique, the result will not be optimal. Another of the most recent lines of research has as its object of study the resection or not of the orbicularis oculi muscle in its preseptal portion; however, despite efforts to improve the evidence, no statistical significance has been found to support one or another surgical option to declare it superiority [4] [5].

Finally, within the studies to improve the outcomes in periorbital surgery,

there is the measurement of static anthropometry in the pre-operative period, since it has been observed that the meticulous measurement of the anthropometric characteristics of the patients is the fundamental pillar to trace the adequate therapeutic route in the trans-operative period. This systematization has improved postoperative satisfaction, avoiding a considerable percentage of short- and long-term complications, specifically asymmetry in the eyelid and eyebrow shape and position.

Recent papers on periorbital anthropometry have been published around the world, predominantly in the Caucasian and Asian populations; however, it has not yet been studied in the Latin population and specifically in the Mexican population [6]. This is why we consider it vitally important to know these measures since it will allow us to improve preoperative markings in Mexico and Latin America population, as well as, postoperative results.

The aim of the study was to describe the static anthropometry of the upper eyelid and the eyebrow in the Mexican population attended a national referral hospital in Mexico City.

2. Materials and Methods

A prospective observational and cross-sectional study of patients referred to the Plastic and Reconstructive Surgery service in a tertiary national reference center. Eyelid anthropometry was performed on each of the patients as a protocol to establish the diagnosis and surgical plan with the checklist created and applied by the service.

Anthropometry of the palpebral fissure and the position of the eyebrows. The anthropometric measurement of the palpebral fissure and the position of the eyebrows were performed by the same researcher. In anatomical position, looking at the horizon and using a caliper ruler, the Marginal Reflex Distance (MDR1), the tarsal thickness (from the ciliary edge of the eyelid to the tarsal groove), the length of the vertical and horizontal slit, and finally the external edge is located with respect to the internal edge (**Figure 1**). For eyebrow anthropometry, the distance from the eyebrows to the hairline implantation, the distance of the orbital rim with respect to the eyebrow, and the angle of the apex of the eyebrow were measured. All measurements were expressed in millimeters (**Figure 2**).

3. Results

A total of 210 patients were obtained, 65 males and 145 females with a mean age of 38.37 years. These were divided by sex and into age groups, as has been done in other anthropometric studies (**Table 1**). The mean age in females was higher than in the group of males associated with the number of female patients in the range of 41 to 50 years.

In the anthropometric analysis of the vertical palpebral fissure in the group of 20 to 30 years, a higher mean was observed in females (9.79 mm) compared in

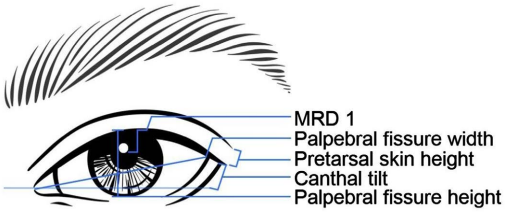

Figure 1. Palpebral and periorbital anthropometry.

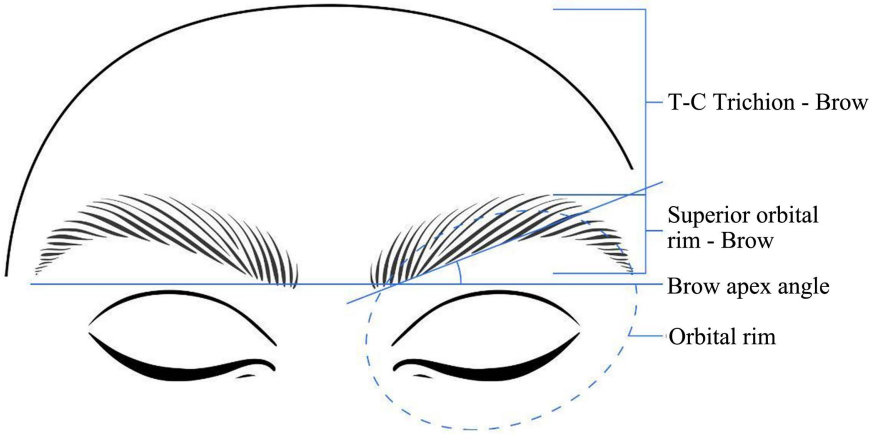

Figure 2. Eyebrow anthropometry.

Table 1. Distribution by age groups and sex.

	Male	Females
Age (mean)	32.69	44.09
20 - 30 years (n)	25	40
31 - 40 years (n)	35	20
41 - 50 years (n)	5	85
Total	65	145

males of the same group age (9.51 mm), a similar result within the groups of 31 to 40 and 41 to 50 years. On the other hand, the mean horizontal slit was higher in male in all 3 age groups.

The mean tarsal thickness was significantly higher in females of the 3 age groups (9.2 mm, 9.2 mm, and 8.9 mm, respectively), compared in male gender (7.4 mm, 7.3 mm, and 6.9 mm). Regarding the MDR1, the result was similar between both sexes, mainly in the age groups of 20 - 30 years and 31 - 40 years. In the group between 41 and 50 years old, when compared with the group between 20 and 30 years old, significant decreases were observed in the vertical groove, tarsal thickness and position of the external edge (Table 2).

In the anthropometrical eyebrows analysis, it was observed in the group of 20 to 30 years that the distance from the trichion to the eyebrow was greater in males (54.7 mm) than in females (44.6 mm), the position of the eyebrow with respect to the supraorbital rim showed that in females there is a greater distance

Table 2. Eyelid anthropometry by gender and age group.

Parameter (mm)	Male mean (SD)	Female mean (SD)
20 - 30 years		
Vertical fissure	9.51 (0.9)	9.79 (1.1)
Horizontal fissure	29 (2.7)	27.96 (1.8)
Tarsal thickness	7.4 (2)	9.2 (2.1)
MDR1	3.61 (0.5)	3.5 (0.6)
Canthal position (Degrees of inclination)	3.5 (0.6)	4.2 (0.8)
31 - 40 years		
Vertical fissure	9.41 (0.5)	9.69 (0.8)
Horizontal fissure	28.5 (2.2)	27.2 (1.2)
Tarsal thickness	7.3 (1.5)	9.25 (1.8)
MDR1	3.5 (0.4)	3.5 (0.4)
Canthal position (Degrees of inclination)	3.1 (0.4)	3.9 (0.9)
41 - 50 years		
Vertical fissure	9.22 (0.6)	9.33 (0.4)
Horizontal fissure	28 (1.8)	27 (1.1)
Tarsal thickness	6.9 (1.1)	8.9 (0.8)
MDR1	3.1 (0.3)	3.3 (0.8)
Canthal position (Degrees of inclination)	2.2 (0.9)	2.7 (1.5)

(5.4 mm) than in males (1.5 mm) and finally the angle of the apex of the eyebrows was measured and it was obtained that the mean of this angle was greater in females than in males. In the other groups, the trends were maintained; however, a decrease was observed in the angle of the apex of the eyebrow and the RSO-eyebrow distance in males and females with advancing age, being more important in the group of 41 to 50 years. Oppositely, the distance from the trichion to the eyebrow increased as the age of the patients studied in the group of females and males increased (Table 3).

Within the study, some characteristics of the eyelids were studied, such as rhytness, herniation of fat pads, hypertrophy of the orbicularis oculi muscle and lacrimal gland herniation, dividing them into each of the age groups. The trends found were that a higher percentage of rhytism, herniation of fat pads of the upper eyelid and lacrimal gland herniation were observed at older ages. The characteristic that did not meet this condition is the presence of hypertrophy in the orbicularis oculi muscle, where greater hypertrophy of the muscle was observed in the younger age group, decreasing as age progressed (Table 4).

4. Discussion

The eyelid appearance is a key element in the definition of beauty and age perception, even in some cultures the shape of the eyelid was synonymous with fertility.

Table 3. Eyebrow anthropometry by group of men and women.

Parameter (mm)	Male mean (SD)	Female mean (SD)
20 - 30 years		
T-C	54.7 (6.6)	44.6 (5.8)
SOR-eyebrow	1.5 (0.7)	5.4 (3.3)
Eyebrow apex angle	6.2 (3.7)	7.7 (2.5)
31 - 40		
T-C	56.1 (7.1)	44.1 (6.9)
SOR-eyebrow	1.6 (0.9)	5.1 (3.1)
Eyebrow apex angle	5.9 (3)	7.4 (2.1)
41 - 50		
T-B	52.1 (5.5)	41.3 (4.4)
SOR-eyebrow	1.1 (0.7)	4.4 (2.5)
Eyebrow apex angle	4.6 (2.1)	6.7 (2.2)

T: Trichion; B: Brow; SOR: Supraorbital Rim.

Table 4. Qualitative variables evaluated in the upper eyelid.

Parameter	Male (%)	Female (%)
20 - 30 years		
Wrinkle		
Yes	8%	38%
No	92%	62%
Fat pads		
Without herniation	92%	55%
With herniation	8%	45%
Palpebral orbicularis		
No hypertrophy	90%	66%
With hypertrophy	10%	44%
Lacrimal gland		
Without herniation	0%	93%
With herniation	100%	7%
31 - 40 years		
Wrinkle		
Yes	25%	48%
No	75%	52%
Fat pads		

Continued

Without herniation	83%	51%
With herniation	17%	49%
Palpebral orbicularis		
No hypertrophy	91%	70%
With hypertrophy	9%	30%
Lacrimal gland		
Without herniation	33%	75%
With herniation	67%	25%
41 - 50 years		
Wrinkle		
Yes	55%	68%
No	45%	32%
Fat pads		
Without herniation	42%	33%
With herniation	58%	67%
Palpebral orbicularis		
No hypertrophy	90%	69%
With hypertrophy	10%	31%
Lacrimal gland		
Without herniation	30%	39%
With herniation	70%	61%

However, this perception is variable according to each geographical region of the world, since it not only depends on geolocation, but also on the body constitution of each of the races or ethnic groups.

Understanding the anatomical and physiological factors that take part in the suitability of eyelid aesthetics plays a very important role, as well as systematically study of the eyebrow, the upper eyelid and the lower eyelid as a unit (using a comparison tool) as described by Avalos *et al.* [7] in 2020, allowing a comprehensive diagnosis to optimize surgical results. One of the great limitations is the lack of extrapolation of the anthropometric standards in the world literature, since they are variable between races and average measurements between such different populations [8]. In the population studied, the basic anthropometric measurements of the eyelid were reviewed and it was found that they are quite similar to those referenced in the universal literature; however, significant differences were found between the different groups established by age and sex.

The relationship between vertical palpebral fissure and age has already been studied in the past. Our results in both sexes are consistent with previous stu-

dies, finding that as age increases, there is a noticeable decrease in the length of this fissure, a similar finding was observed by Erbagci *et al.* who found a gradual decrease in the palpebral fissure with increasing age, contrasting with Van den Bosch *et al.* who described that the vertical length was only reduced by 10% after 45 years [2]. The relationship of the horizontal fissure with age has also been studied, in the study it was found that it remains constant in all groups with minimal variations.

The gradual reduction of the vertical fissure with advancing age is due to factors such as decreased of levator muscle excursion, decreased MDR1, increased eyelid weight due to herniation of fat-pads, dermatochalasis, elongation of the levator palpebrae eyelid or simple degeneration of the same [9]. A very important factor to study is the eyebrow and the upper eyelid as an interdependent unit. Therefore, if the eyebrow is ptotic, there will be a decrease in the vertical cleft, not because of the eyelid itself, but because of the interdependence of these facial structures.

Since ancient times, tarsal thickness has been a sign of beauty and even femininity in many cultures around the world. Its anthropometric study is of vital importance, since during a surgical procedure, its preservation or reconstruction is essential objectives [10]. In this study, it was observed that its thickness was greater in females compared to in the group of males and gradually decreased in both groups with increasing age. This reduction was secondary to the modification due to aging of the adjacent structures that influence their dimension (fat pads, dermatochalasis, hypertrophy of the orbicularis muscle, elongation or atrophy of the levator palpebrae, and even neurological causes). Before aging changes, the tarsal thickness in the study was similar to that of other studies conducted in other regions of the world.

The vertical and horizontal fissures are important in the structure of the periorbital region; however, the inclination vector is typically the object of correction in surgery to modify the eyelid shape, support and aesthetics. In the study, the slope of the cleft gradually decreased from the youngest to the oldest group, however, the results were not statistically significant. Unlike the comparison between men and women, where a more inclined intercanthal vector was found in the group of women. In contrast on the findings published by Odunze *et al.* who described significant differences between women equal to or less than 45 years old compared to those older than that age in the white and Afro-American population [2]. They conclude that the lateral canthus descends with age, mainly in the studied group of African-American women. The evaluation of this vector is decisive since its modification, in the case that it is warranted, is a priority due to the functional and aesthetic importance it confers, the omission of its importance could compromise the postoperative result causing aesthetic dissatisfaction on the part of the patient.

The shape of the eyebrow is an aspect that has been studied for centuries, and has gone through different concepts trying to arrive at the ideal shape. It is currently accepted that this shape is different between the sexes, being found in

women up to 1 cm above the orbital rim and with a marked apex of the eyebrow, in men above the rim and with an apex that has a smaller angle. With increasing age, a decrease was observed in the distance from the orbital rim to the eyebrow and in the degrees of angulation of the apex, this is due to the increase in the laxity of the periocular tissues that decreases the fixations of the eyebrow [11].

Finally, when describing the characteristics of rhytness, herniation of fat pads and characteristics of the orbicularis oculi muscle, no really transcendent changes were seen between both sexes, only the changes corresponding to the aging process were observed.

5. Conclusions

Systematized palpebral and periorbital anthropometric analysis is fundamental in the evaluation consultation. Determining the position of each of these structures gives an accurate diagnosis of the functional and aesthetic alterations that must be corrected during a surgical procedure, taking into account all the factors that intervene in the conservation or distortion of its anatomy.

Having a reference in the Mexican population anthropometry is essential to understand what are the standards that should be considered ideal when correcting or reconstructing periorbital units or structures, since the references in world literature are not always applicable to our population due to its physical constitution and even aesthetic standards that are influenced by culture and region. The changes observed in the different study groups correspond to changes specific to sex and due to the aging process suffered by the population.

Multicenter studies including more study groups are necessary to accurately define the anthropometric data obtained in the study.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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