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A Comparison of Lower Eyelid Retraction in Normal Individuals with Positive versus Negative Orbital Vector

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Abstract:

PURPOSE: The present study aimed to compare lower eyelid retraction (LER) in individuals with a positive orbital vector with that of individuals with a negative orbital vector.

MATERIALS AND METHODS: This cross-sectional study was conducted on 123 normal individuals including 64 men and 59 women aged 20–80 years. After the individuals underwent Hertel exophthalmometry, two side-view and front-view photos were taken using a camera. The orbital vector angle and the extent of scleral show were then measured in millimeter, using the Photoshop software. Eventually, the recorded data were analyzed through statistical software.

RESULTS: The findings of this study showed that LER has a significant correlation with orbital vector angle and the extent of proptosis ($P < 0.05$). The mean value of orbital vector angle in individuals without LER was 9.76° , while this figure was calculated to be -13.65° in individuals with LER. The mean protrusion value based on Hertel exophthalmometry was 14.08 mm in individuals without LER and 16.27 mm in individuals with LER. The extent of scleral show had a significant correlation with proptosis and orbital vector angle ($P = 0.01$), with a mean value of -0.41 mm in individuals without LER and 0.94 mm in participants with LER.

CONCLUSIONS: The prevalence of LER and scleral show is positively correlated with the extent of proptosis and negatively correlated with orbital vector angle.

Keywords:

Hertel exophthalmometry, lower eyelid retraction, proptosis, scleral show

Introduction

The bony orbit and periorbital area is comprised of various tissues that can affect the orbital vector and create different anatomical variations, one of which is the negative orbital vector (NOV), most frequently seen in individuals with prominent eyes. The term NOV was first described by Jelks and Jelks as a condition where the most anterior aspect of the globe lies anterior to the malar eminence and the orbital rim. The opposite positioning of these

elements relative to each other is referred to as a positive orbital vector (POV).^[1,2]

Since the development of the orbital cavity is completed by the age of 3 years, any increase in internal contents of the cavity after this age presents as changes in the position of the globe, which is always along the anterior vector that has the least resistance. Anterior displacement of the eye is referred to as exophthalmia or proptosis, which occurs as a result of an imbalance between the capacity of the orbital cavity and the volume of its internal contents and is the most common presentation of

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Graves' ophthalmopathy and orbital injuries due to tumors, vascular lesions of inflammation. It should be noted that there is a normal variation in the extent of exophthalmia in the healthy population that is affected by age, ethnicity, gender, etc.^[3-6]

There are various congenital and acquired conditions that determine the position of the eye in the orbital cavity, and some of these variations can make patients more susceptible to postoperative complications after procedures such as blepharoplasty or other surgeries. These complications that are reported to be more frequent after interventions on the lower eyelid and in individuals with NOV include defects in eyelid closure, eyelid retraction, and poor cosmetic outcomes such as too much scleral show.^[7-9] Accordingly, identifying the factors associated with these complications and evaluating patients for their presence are of great importance. One of the most important factors that could cause a prominent eye and can complicate orbital surgeries is the presence of an NOV that has been frequently reported to be associated with lower eyelid retraction (LER). In this regard, we aimed to compare LER in individuals with POV with that of individuals with NOV.

Materials and Methods

Study design and sample population

In this cross-sectional study, 123 normal individuals, including 64 men and 59 women aged 20–80 years, were randomly selected from the companions of patients referring to Farabi Eye Hospital Hospital in 2014, using a convenience sampling method. Exclusion criteria were pregnancy, history of any eye diseases, history of trauma to the eye, any past orbital or eyelid surgery, eye deviation, inflammatory orbital diseases, endocrine disorders, trauma or history of orbital fractures, myopia >5 diopters, infections such as orbital cellulitis, and facial and mandibular congenital malformations.

Ophthalmologic evaluations

Hertel exophthalmometer was used by a single ophthalmologist. The individuals sat in front of the examiner, both at the same level, with the eyes looking at a distant object. The examiner set the footplates of the Hertel device on the lateral walls of orbits on both sides. Then, the examinees were asked to focus their left eye on the right eye of the examiner and vice versa. By visualizing the side view of the cornea in the lateral mirror and setting the red line on the white notch, the vertical distance between the corneal apex and the lateral wall of the orbit was measured and recorded.

After the individuals underwent Hertel exophthalmometry, two side-view and front-view photos

were taken using a Canon EOS 7D digital camera, with the participant sitting and looking straight at a distant object. Then, the photos were opened by the Photoshop CS6 software (Adobe Systems, Inc. San Jose, CA, USA), a line was drawn from the inferior orbital rim (which was marked by palpation before photography) to the corneal apex and another line was drawn vertical to the inferior rim, and the angle between these two lines was measured as the orbital vector angle. If the vertical line is behind of tangent line to the cornea, this is called NOV, and the angle between these two lines is shown with negative values [Figure 1a]. When the vertical line is in front of the tangent line to the cornea, it is called POV which is shown with positive values [Figure 1b]. If the tangent line to the cornea corresponds to the vertical line, this is called the zero orbital vector [Figure 1c].

LER was diagnosed when the sclera was visible above the lower eyelid (inferior sclera show). The extent of scleral show was measured in millimeter from the inferior corneoscleral limbus, and it was entitled positive if it was positioned inferior to the corneoscleral limbus and termed negative if it was over it. Scleral show was normalized based on the diameter of cornea, considered as 11.50 mm in normal individuals, to eliminate the effect of magnification in the software.

Ethical considerations

The aims and methods of the study were thoroughly

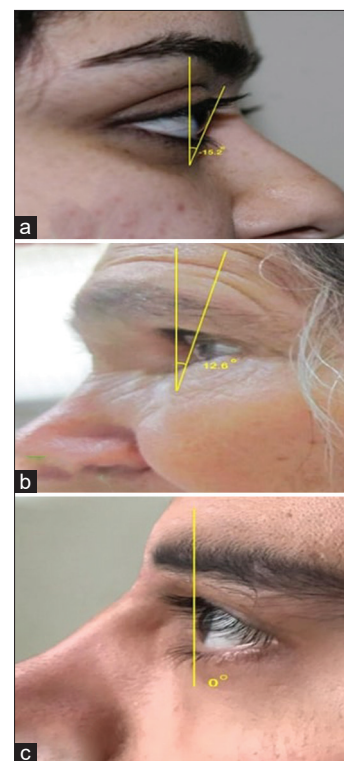


Figure 1: (a) Negative orbital vector which is - 15.2. (b) Positive orbital vector which is + 12.6. (c) Zero orbital vector

explained to the participants; they were reassured that their inclusion in this survey will not have any adverse effects for them, their data will be considered confidential, used anonymously, and will only be accessible by the main researchers of the study, and they can withdraw from the study at their will. Informed written consent was obtained from the individuals willing to participate. The Ethics Committee of Tehran University of Medical Sciences reviewed and approved the study protocol. The survey was conducted in accordance with the guidelines of the Helsinki's Declaration.

Statistical analysis

Data were entered into SPSS software for Windows version 22.0 (IBM Corp., Armonk, NY, USA) for analysis. Descriptive statistics of the results were presented as frequency and percentage for qualitative variables and as mean and standard deviation for quantitative ones. To assess the correlation between these factors, the Chi-squared test and Fisher's exact test were used as needed for qualitative variables. Statistical significance was defined as $P < 0.05$ in all analyses.

Results

A total of 123 normal individuals, including 64 (52%) men and 59 (48%) women aged 20–80 years, were included in this study. The majority of the participants (35%) were 20–30 years old. Table 1 presents the demographic

Table 1: Demographic characteristics of the sample population and ophthalmologic findings

Variable	Frequency (Percent)
Age group (year)	
20-40	77 (62.6%)
41-60	23 (18.7%)
61-80	23 (18.7%)
Gender	
Male	64 (52%)
Female	59 (48%)
Orbital vector angle (degree)	
-14-10	26 (21.1%)
10-14	49 (39.8%)
14-18	35 (28.5%)
> 18	13 (10.6%)
Exophthalmometry Value (mm)	
6-10	16 (13%)
10-14	29 (23.6%)
14-18	63 (51.2%)
18-22	15 (12.2%)
Scleral show (mm)	
-1-0	62 (50.4%)
0-0.25	2 (1.6%)
0.25-0.5	13 (10.6%)
0.5-1	23 (18.7%)
1-2	22 (17.9%)
>2	1 (0.8%)

characteristics and ophthalmologic findings of the study. The mean angle of orbital vector was found to be significantly lower in individuals with LER (-13.65°) compared to LER-negative participants (9.76°) ($P = 0.002$). The mean of orbital vector angle was calculated to be $11.69^\circ \pm 7.08^\circ$, with a minimum and maximum of -14° and 26.6° , respectively. The mean value calculated for men and women was $11.49^\circ \pm 6.79^\circ$ and $11.91^\circ \pm 7.45^\circ$, respectively, and the differences were found to be insignificant. According to the correlation coefficient calculated for the relation between orbital vector angle and age of the participants, there was a strong positive significant correlation between the two with a coefficient of 1 to -0.644 ($P < 0.001$) [Figure 2]. This correlation was found to be more prominent in the age group of 60–80 years [Figure 3]. The orbital vector angle had a negative linear correlation with scleral show ($P = 0.001$) [Figure 4]. The mean Exophthalmometry Value (EV) in participants with LER (14.08 mm) was significantly higher than that of the LER-negative individuals (16.27 mm) ($P = 0.002$). EVs had a positive linear correlation with scleral show ($P = 0.001$) [Figure 5]. EV had a negative linear correlation with the angle of orbital vector as well ($P = 0.001$) [Figure 6]. The mean scleral show was found to be significantly lower in LER-negative individuals (-0.41 mm) compared to participants with LER (0.94 mm).

The mean EV was 15.16 ± 3.52 mm, ranging from 6 to 22 mm. Most of the participants (51.2%) had EVs ranging from 14 to 18 mm. The mean EVs calculated for men and women were not significantly different from each other (15.30 ± 3.57 mm vs. 15.00 ± 3.50 mm). However, there was a strong negative correlation between age and EV with a correlation coefficient of 1 to -0.620 ($P < 0.001$).

Among the 123 participants, in 57 (46.3%) individuals, scleral show was found to be zero or negative. The

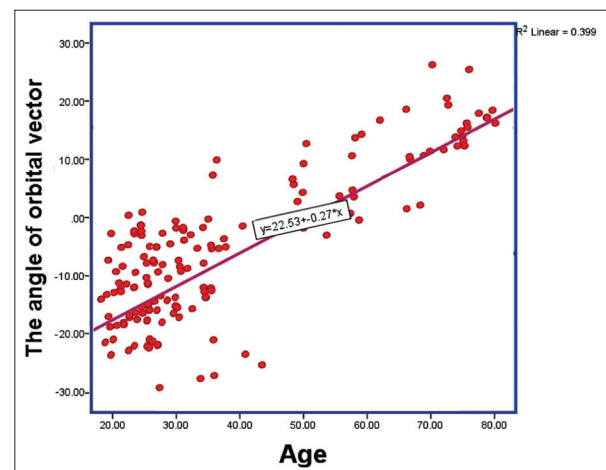


Figure 2: Correlation between age and the angle of orbital vector

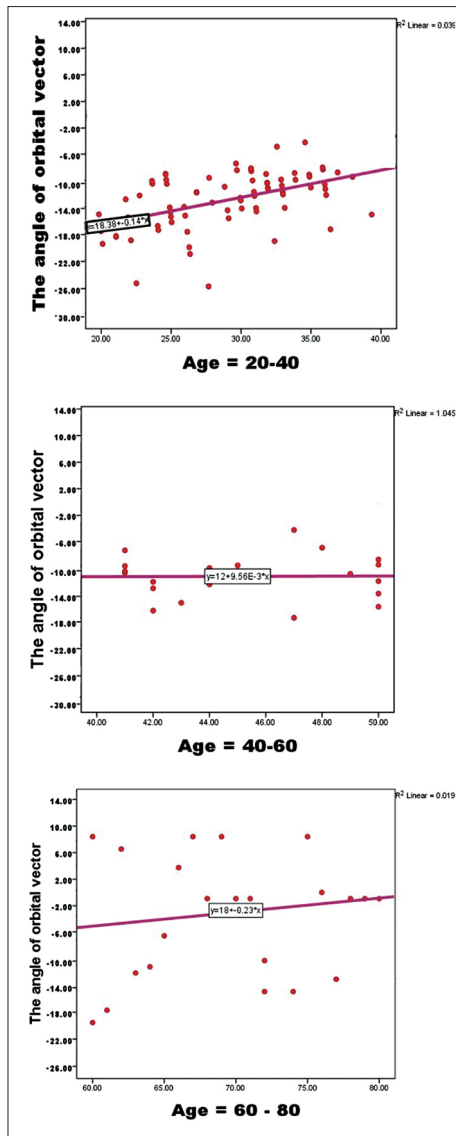


Figure 3: Correlation between age and the angle of orbital vector in different age groups

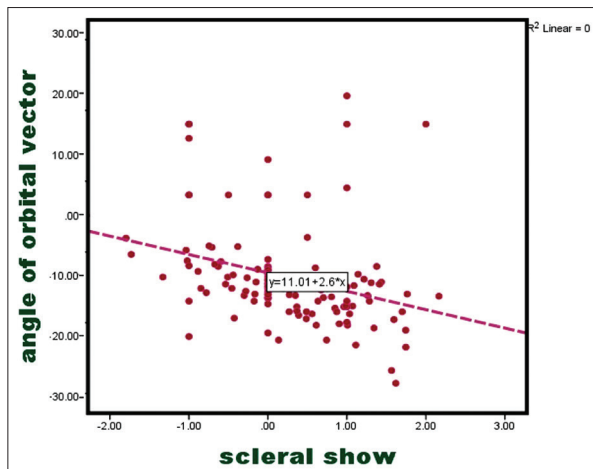


Figure 4: Correlation between the angles of orbital vector with scleral show

mean scleral show was calculated to be 0.41 ± 0.68 mm, ranging from -1 to 2.31 mm. This figure calculated for men was 0.56 ± 1.82 mm, which was not significantly different from the 0.47 ± 0.66 mm calculated for women. Moreover, there was no significant correlation between age and scleral show.

A total of 61 individuals (49.6%) were found to have LER and a scleral show >0 , while 62 participants (50.4%) had no LER. The Chi-squared test showed no significant correlation between gender and the presence of LER. On the other hand, the age of individuals with LER was found to be significantly lower than the participants with no LER (36.98 ± 16.57 vs. 42.56 ± 15.89 years; $P = 0.001$).

Discussion

Jelks and Jelks have emphasized on the importance of identifying patients with NOV that are typically more susceptible to developing complications after standard blepharoplasty and would benefit from further complementary techniques during their surgeries.^[1] In another study, Hirmand *et al.* have evaluated the effects of classifying patients according to the extent of their exophthalmia, detection of patients with prominent eyes, and making modifications to the surgical methods for these patients in decreasing the incidence of complications after blepharoplasties.^[10] Postsurgical complications are very important for both the patient and physician, particularly after cosmetic surgeries. The most common complication after lower eyelid blepharoplasty is malposition of the lower eyelid which can present as a slight scleral show or even a prominent ectropion.

In this regard, we aimed to evaluate the correlations between LER, the angle of orbital vector, and the extent of proptosis in this study. According to our findings, LER has a positive correlation with the extent of proptosis and a negative correlation with the angle of orbital vector. The angle of orbital vector also had a negative correlation with the extent of proptosis. Although none of the evaluated factors in this study had a significant association with the gender of the participants, age showed a negative correlation with the extent of proptosis and a positive correlation with the angle of orbital vector. On the contrary, to the last finding, Pessa *et al.* reported a positive correlation between EVs and age of their individuals.^[2]

Ahmadi *et al.* on the orbits of 653 Caucasian patients aged 21–80 years reported a negative significant correlation between eye proptosis and age.^[11] Mourtise *et al.* also found a significant reduction in eye proptosis with increasing age.^[6] These findings could be attributed to the fat drop and retraction of orbital rim with aging.

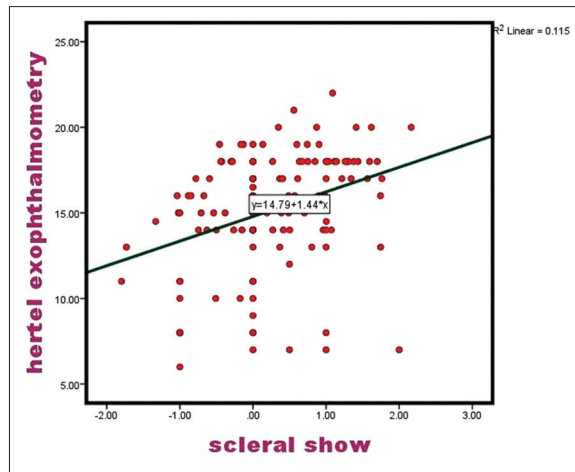


Figure 5: Correlation between exophthalmometry value and scleral show

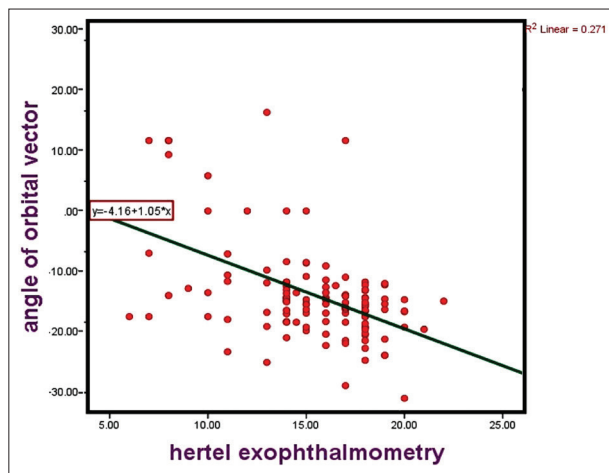


Figure 6: Correlation between exophthalmometry value and the angle of orbital vector

However, in their study on 320 patients aged 10–89 years, van den Bosch *et al.* showed that aging is associated with sagging of the lower eyelid, particularly in men, but it does not affect the position of globe.^[12] In another survey, compatible with our results, Mackinnon *et al.* found no significant correlation between scleral show and LER with either age or gender of the participants.^[13]

One of the important factors that can lead to a prominent eye and can complicate orbital surgeries is the presence of a negative vector orbit. The findings of our study also showed that healthy individuals with NOV are more at risk of LER, compared to individuals with POV. Considering the results of this study along with the findings of previous surveys, physicians should thoroughly examine their patients before surgical interventions to identify the individuals at risk of unwanted changes in their lower eyelids, so that they could take preventive or supplementary measures during the intervention to minimize these complications.

For precise assessment of the anatomical aspects of the orbit, standard indices should be developed, to which the measurements could be compared. Considering the ethnic differences between various populations, these standards should be developed for each population separately. It is suggested that further investigations focus on developing these standard nomograms for different age groups.

Conclusions

Aging is associated with a decrease in the extent of proptosis and an increase in the angle of orbital vector, particularly in the age group of 60–80 years. The frequency of LER is also expected to be higher in normal individuals with greater proptosis and lower orbital vector angle.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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