Angular Relations of Upper Corneal Coverage by Upper Lid Margin in Relation to Central Corneal Reflex in Normal Subjects of Shimla Hills

Aditya Kashyap1, K P Chaudhary2, M L Pandey2
1Mahatma Gandhi Medical Services Complex, Rampur, Shimla, Himachal Pradesh, India
2Department of Ophthalmology, Indira Gandhi Medical College, Shimla, Himachal Pradesh, India

Abstract

Aim: To study relations of Upper Lid Margin in relation to Central Corneal Reflex (CCR) in normal healthy subjects of Shimla Hills.

Design: Comparative Case series involving 800 eyes of 400 subjects attending the OPD, were divided into four equal groups, males <18 years, females <18 years, males ≥18 years but <35 years and females ≥18 years but <35 years into group A, B, C and D respectively. The angular relations of upper lid (UL) in relation to CCR were calculated in computer using Goniometer, after magnifying images taken from Sony Super Steady Shot 8 megapixel Digital Camera. Three reference points on UL were taken from the spots where the UL touches the nasal side of corneal limbus (N), on temporal side of corneal limbus (T) and the midpoint of UL (point M). Then a point was taken from CCR (R). Angles thus formed on joining the above points i.e. NRT, MRT and NRM were measured using Goniometer.

Results: Angle NRM values had an overall mean of 69.87°±5.75°
Angle MRT values had overall mean of 58.41°±5.59°
Angle NRT values had an overall mean of 128.13°±10.49°.

Conclusion: 1)Angle MRT is more or less constant in all ages and in both sexes
2)Angle NRM variations are seen with advancing age especially among females.
3)Angle NRT which is constituted by angles MRT and NRM, varies with advancing age and especially in females. These findings may be taken into account in preoperative assessment and while planning postoperative outcome in all surgical procedures of eyelid, like ptosis correction.

Keywords: Upper Eyelid (UL) , Central Corneal Reflex (CCR), Upper Eyelid Margin (ULM)

Introduction

Various different parameters have been described in defining the beauty of eyes.1 Of those the angular relations of upper lid (UL) in relation to central corneal reflex (CCR) must have been of paramount importance, as beauty of the eyes is maintained especially by the position of UL. In younger people, the arc of the upper lid often peaks medially, forming a true almond shaped eyelid aperture which is otherwise also reflected in description of a beautiful face in various artistic forms.2 The aim of all surgical procedures that involve the UL like ptosis surgery etc. is to achieve and maintain the near anatomical position of UL.3 But to the best of our knowledge, no study is available which describes the ULM-CCR relations in terms of angular values. All the previous studies described the Margin reflex distance MRD4 i.e. distance between central part of UL and CCR, ignoring the nasal and temporal touch of upper cornea and their relation to CCR. Hence we undertook this study to describe angular relations of ULM to CCR in normal eyes of healthy subjects to enable setting targets after lid contour surgeries.

Materials and Methods

The study was conducted in the Department of Ophthalmology, Indira Gandhi Medical College, Shimla after taking due permission of ethical committee of the institute. Patients visiting the Outdoor Patient Department (OPD) during the period of one year, from August 2008 to August 2009, who fulfilled the selection criteria were enrolled. They were divided into four groups, as:
Group A = Males having age less than 18 yrs.
Group B = Females having age less than 18 yrs.
Group C = Males having age 18-35 yrs.
Group D = Females having age 18-35 yrs.

Subjects having age more than 35 years were not enrolled for the study to minimize effects of senile changes in the study, as after average age of 35 years the horizontal eyelid fissure gradually shortens by about 2.5 mm.5

Exclusion criteria included presence of Myasthenia Gravis, myopathies, skin abnormalities, high refractive error (myopia / hypermetropia > 4 D), abnormal suspicious eyelash dimension, infective ocular conditions or orbital inflammation, lenticular opacities, subjects having abnormal visual axis, lid abnormalities, old trauma, photophobia.

Each subject was subjected to Visual acuity testing using Snellen’s chart or Landolt ring chart placed at a distance of six meters. Slit Lamp biomicroscopic evaluation of the eyes...
Results

The angles NRT, MRT, NRM (Figure 2,3) were evaluated in all 400 subjects, in both the eyes. The angles calculated were then subjected to Descriptive Statistical analysis using Epi Info® Software. The mean values of all the angles were calculated along with S.D. and S.E. The overall mean values of angles were 128.1284°, 58.4082°, 69.8741° for Angle NRT, Angle MRT, Angle NRM respectively

Angle NRT

Highest mean angle NRT (Figure 2) values were encountered in Group B patients (female children) which were found to be statistically significant when compared with Group D (female adults), who otherwise had the least mean values of angle NRT when compared to all groups. The mean difference in angle means was found to be around 4° Angle MRT

The highest mean value of Angle MRT were found in Group B (female children) and the lowest mean values were found in Group C (male adults) having a mean difference of approximately 1°, which was not statistically significant.

Angle NRM

Highest mean angle NRM values were encountered in Group B patients (female children) which were found to be statistically significant (p < 0.05) when compared with Group D (female adults) who otherwise had the least mean values of angle NRM, when compared to all groups and the mean difference in angle means was found to be around 3°. The values thus calculated were subjected to ANOVA test, to compare individual means with the combined means which showed that the values of Angle NRT (OU) and Angle NRM (OU) were found to be statistically significant (p < 0.05)
when compared with total mean angle values, that is angles NRT and NRM values were found to be more fluctuating. On comparing the values & means of calculated angles in Group A and B it was observed that statistically significant difference was seen in the values of angle NRM within these two groups \( p \text{ value} = 0.0244 \) (OD), 0.0332 (OS)\)

This was also observed on comparing the means of calculated angles in Group B and D (using ‘z’ test for the assessment of any statistical significance) where statistically significant difference was seen in the values of angles NRM and NRT

NRT (OD) P value 0.0046  
NRT (OS) P value 0.0068  
NRM (OD) P value 0.0006  
NRM (OD) P value 0.0016

No statistically significant difference was seen in the values of any angle within groups C & D, A & C.

**Discussion**

Since times immemorial various artists, poets, lyricists’ sculpturists & craftsmen have described the beauty of eyes in comparison to the things seen in daily lives. While doing so, it must have been in the subconscious mind of all those artists to mathematically calculate the various parameters describing the beauty of eyes. Out of those various parameters considered, the angular relations of UL in relation to CCR must have been of paramount importance, as beauty of the eyes is maintained especially by the position of UL, which is reflected in describing a beautiful face. It was thought appropriate to know the angular dimensions of ULM in relation to CCR, hence the angle NRT which is equal to sum of angles MRT and NRM, was formulated in normal healthy subjects. (Figure 2)

The study was planned in normal healthy subjects’ upto the age of 35 yrs. in Shimla Hills, of both sexes, with intermingled races of mongoloid origin residing in these areas. Shimla Hills is the term given to an area comprising 19 princely states of earsthrough British Indian empire in and around Shimla, comprising parts of modern districts of Shimla, Solan, Kinnuar. Shimla hills lie between the longitude 77°-0” & 78°-19” east and latitude 30°-45” and 31°-44” north. The elevation of the Shimla hills ranges from 300 to 6000 metres. Nestled in Himalaya these areas had people living in closed communities cut off from outside world till recent times, except for a limited area surrounding Shimla town. Almost all marriages took place within the community. By virtue of their existence at an average altitude of 2100 meters above sea level and being an isolated closed community up to recent times, they form an ideal study group. With intermingled races of mongoloid origin residing in these areas, this area presents additional study group of mongoloid race also. The findings of this study can be presumed to be that of highlanders, as the mean height of Shimla hills is 2100 meters and it is located in Sub Himalayan region. Although at such altitude, other factors which may influence values of angular calculations, like dry eye can be encountered in elderly, as found by Lu P et al in another study conducted in Tibet (another Sub Himalayan region). Moon C S et al has also reported that MRD1, MRD2, the distance between medial and lateral canthus, and the horizontal distance between lateral canthus and corneal center were longest in people of the 3rd and 4th decade, and decreased in later years. To minimize the effect of all these factors on angular measurements 11 younger subjects were chosen in our study (age < 35 yrs). We found that the angular relations of upper corneal coverage in relation to CCR vary with age. That variation is more consistently seen in female subjects where the angles were found to have highly significant statistical variation, in terms of decrease in angular values with increasing age. Angle NRT (Figure 2) values in male subjects were found to decrease numerically up to approximately 1° when comparing pediatric age group with adult age group \( \text{Group A values} = 128.05^\circ \) (OD), 128.1° (OS), \( \text{Group C values} = 127.32^\circ \) (OD) 127.35° (OS)\). Where as in females angle NRT values were found to decrease numerically up to approximately 4° when comparing pediatric age group with adult age group, which is statistically significant \( \text{Group B values} = 130.57^\circ \) (OD), 130.54° (OS), \( \text{Group D values} = 126.47^\circ \) (OD) 126.63° (OS)\) (Table 1). These findings are consistent with the work of Cartwright M. J et al who did measurements of upper eyelid and eyebrow dimensions in 143 healthy white individuals and had shown that an age effect was observed for all measures, indicating a direct relationship with age until the middle age range. Our findings also were consistent with the finding of Bosch WAV et al who noticed that aging mainly affects the size of the horizontal eyelid fissure\(^6\), which lengthens by about 10% between the ages of 12 and 25 years as increase in horizontal fissure size will also have impact over UL dimensions which will cause appreciable changes in angular values between that particular age variation. Variations were mainly seen in the main values of angle NRM (Figure 2) between groups and it was seen to decrease with advancing age in both males and females. In male subjects angle NRM was seen to decrease up to 0.4° in adults when compared with pediatric age group \( \text{Group A values} = 69.65^\circ \) (OD), 69.63° (OS), \( \text{Group C values} = 69.28^\circ \) (OD), 69.31° (OS)\) (Table 1). Whereas in females angle NRM values were found to decrease numerically up to approximately 3° in adults which was statistically significant \( \text{Group B values} = 71.65^\circ \) (OD), 71.55° (OS), \( \text{Group D values} = 68.84^\circ \) (OD) 69.02° (OS)\) (Table 1). Hence the angle NRM varies more with age due to changes occurring in skin, muscle and lamina. On the basis of this finding it can be postulated that angle NRM is more prone to fluctuations with advancing age, especially in females. The mean values of angle NRM were higher than, when compared with values of angle MRT (Table 1). The values of angle MRT (Figure 2) were possibly lower than those of angle NRM because of fact that the lateral canthus is 2 mm higher than the medial canthus in Europeans and 3 mm higher in Asians. On the basis of this finding it is postulated that angle MRT values are likely be more prone to fluctuations in different races. The values of angle MRT were mostly constant among all the groups (overall mean = 58.41° ± 5.59°). These findings are again in accordance with the work of Bosch WAV et al who had stated that aging does not affect the position of the eyeball proper or of the lateral canthus and had concluded that aging did not affect the position of the pupil centre and the lateral canthus. On the
basis of this finding it is postulated that angle MRT values should be constant within a particular race in all age groups. If we evaluate the final results of our study, then the final average values of angle NRT, NRM, and MRT came out to be 128.13°, 69.87°, and 58.41° respectively. The racial variations in these angles must be there and will be of increased value, as ethnic variations have been seen to influence the MRD which directly influences upper lid position and hence these angles too. The findings of this study can help in preoperative evaluation of ptosis surgery, where presently the post surgical correction aim is limited to achieving desired marginal reflex distance only. If a surgeon knows and calculates these nasal and temporal angular values in addition then he can presumably achieve better cosmetic outcome postoperatively by selectively planning surgical procedures like differential resection of levator palpebrae superioris etc in order to achieve that nasal and temporal angular dimensions postoperatively in ptosis surgery. In addition to the determination of other parameters like MRD etc. the angular dimensions as evaluated in present study should become a prerequisite before attempting any procedure involving lid margin. Further studies are needed in a larger group of subjects of various age groups and races to fully elucidate these angular relations which will be helpful for developing the concept of maintaining the beauty of upper lid margin (ULM) in relation to CCR which is likely to be helpful in attainment of ‘aesthetic’ value of upper eyelid.

### Table 1. Summarizing the values of means calculated

| Sex / Group | Sex / Group | Angle NRT (OD) | Angle NRT (OS) | Angle MRT (OD) | Angle MRT (OS) | Angle NRM (OD) | Angle NRM (OS) | Angle MRT (OS) | Angle NRM (OD) | Angle MRT (OS) | Angle NRM (OS) |
|-------------|-------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| Mean        | F/Group D   | 126.4700°      | 126.6300°      | 58.2200°       | 68.8400°       | 58.200°        | 69.020°        | 100            | 100            | 100            | 100            |
| N           | 100         | 100            | 100            | 100            | 100            | 100            | 100            |
| Std. Deviation | 8.98085°  | 8.95968°       | 4.89399°       | 4.87567°       | 4.83063°       | 4.91335°       | 4.9134         |
| Std. Error of Mean | .89909 | .89957 | .48940 | .48757 | .48306 | .48306 | .49134 |
| Mean        | Fch/Group B | 130.5700°      | 130.5400°      | 58.9200°       | 71.6500°       | 58.9200°       | 71.5500°       | 100            | 100            | 100            | 100            |
| N           | 100         | 100            | 100            | 100            | 100            | 100            | 100            |
| Std. Deviation | 11.3471°  | 11.35063°      | 6.22423°       | 6.57878°       | 6.22909°       | 6.36019°       | 6.3602         |
| Std. Error of Mean | 1.13478 | 1.13506 | .62242 | .65788 | .62291 | .62291 | .63602 |
| Mean        | M/Group C   | 127.3200°      | 127.3500°      | 57.9700°       | 69.2800°       | 58.1000°       | 69.3100°       | 100            | 100            | 100            | 100            |
| N           | 100         | 100            | 100            | 100            | 100            | 100            | 100            |
| Std. Deviation | 9.39684°  | 9.12138°       | 4.75555°       | 5.35616°       | 4.96330°       | 5.12016°       | 5.1202         |
| Std. Error of Mean | .93968 | .91214 | .47555 | .53562 | .49635 | .49635 | .51202 |
| Mean        | Mch/Group A | 128.0495°      | 128.0990°      | 58.3960°       | 69.6353°       | 58.4356°       | 69.6931°       | 100            | 100            | 100            | 100            |
| N           | 100         | 100            | 100            | 100            | 100            | 100            | 100            |
| Std. Deviation | 11.64764° | 11.58315°      | 6.28344°       | 5.99739°       | 6.26165°       | 5.94768°       | 5.94768°       | 59182         |
| Std. Error of Mean | 1.15898 | 1.15257 | .62523 | .59676 | .62306 | .62306 | .59182 |
| Mean        | Overall mean | 128.1284°      | 128.1546°      | 58.3766°       | 69.8554°       | 58.4339°       | 69.8928°       | 100            | 100            | 100            | 100            |
| N           | 400         | 400            | 400            | 400            | 400            | 400            | 400            |
| Std. Deviation | 10.48566° | 10.39500°      | 5.57722°       | 5.81756°       | 5.60100°       | 5.68251°       | 5.68251°       | 52362         |
| Std. Error of Mean | .52362 | .51910 | .27851 | .29052 | .27970 | .28377 | .28377 |

quantitatively in form of angular values in ptosis correction surgery, where presently the post surgical correction aim is limited to achieving desired marginal reflex distance only. If a surgeon knows and calculates these nasal and temporal angular values in addition then he can presumably achieve better cosmetic outcome postoperatively by selectively planning surgical procedures like differential resection of levator palpebrae superioris etc in order to achieve that nasal and temporal angular dimensions postoperatively in ptosis surgery. In addition to the determination of other parameters like MRD etc. the angular dimensions as evaluated in present study should become a prerequisite before attempting any procedure involving lid margin. Further studies are needed in a larger group of subjects of various age groups and races to fully elucidate these angular relations which will be helpful for developing the concept of maintaining the beauty of upper lid margin (ULM) in relation to CCR which is likely to be helpful in attainment of ‘aesthetic’ value of upper eyelid.
Cite This Article as: Kashyap A, Chaudhary KP, Pandey ML. Angular Relations Of Upper Corneal Coverage By Upper Lid Margin In Relation To Central Corneal Reflex In Normal Subjects Of Shimla Hills. Delhi J Ophthalmol 2016;27:16-20.

Acknowledgements: None

Date of Submission: 10/01/2016 Date of Acceptance: 13/05/2016

Conflict of interest: None declared

Source of Funding: Nil

References

1. Patnaik VVG, Rajan S, Sanju KB. Anatomy of A Beautiful Face and Smile. J Anat Soc India 2003; 52:74-80.
2. Lambros V. Observations on periorbital and midface aging. Plast Reconstr Surg 2007; 120:1367-76.
3. Ben Simon GJ, McCann JD. Cosmetic Eyelid and Facial Surgery. Surv Ophthalmol 2008; 53:426-42.
4. Boboridis K, Assi A, Indar A, Bunce C, Tyers AG. Repeatability and reproducibility of upper eyelid measurements. Br J Ophthalmol 2001; 85:99-101.
5. Van den Bosch WA, Leenders I, Mulder P. Topographic anatomy of the eyelids, and the effect of sex and age. Br J Ophthalmol 1999; 83:347-52.
6. Fogla R, Rao SK. Ophthalmic photography using a digital camera. Indian J Ophthalmol 2003; 51:269-72.
7. Attri R. Geography and Demography, Rivers and lakes, Industries.In : ed. Introduction to Himachal Pradesh. 1st ed. Shimla. Sarla Publications Shimla 2000 :145-60,161-71,372-82.
8. Singh MG. The Land, The people. In : Singh MG, ed Festivals, fairs and customs of Himachal Pradesh. New Delhi. Indus Publishing Co., New Delhi 1997: 13-18, 19-27.
9. Gupta N, Prasad I, Himashree G, D’Souza P. Prevalence of dry eye at high altitude: a case controlled comparative study. High Alt Med Biol 2008; 9:327-34.
10. Lu PI, Chen X, Liu X, Yu L, Kang Y et al. Dry eye syndrome in elderly Tibetans at high altitude: a population-based study in China. Cornea 2008; 27:545-51.
11. Moon CS, Moon SH, Jang JW. Topographic Anatomic Difference of the Eyelid According to Age in Korean. J Korean Ophthalmol Soc 2003; 44:1865-7.
12. Cartwright MJ, Kurumety UR, Nelson CC, Frueh BR, Musch DC. Measurements of upper eyelid and eyebrow dimensions in healthy white individuals. Am J Ophthalmol 15; 117:231-4.
13. Murchison AP, Sires BA, Jian-Amadi A. Margin reflex distance in a. different ethnic groups. Arch Facial Plast Surg 2009; 11:303-5.

Corresponding author:
Aditya Kashyap ss
Consultant Ophthalmologist, Mahatma Gandhi Medical Services Complex, Rampur, Shimla, Himachal Pradesh, India
Email: drad2006@rediffmail.com