Original Research Article

# Angular deviation of both eyes in cases of refractive errors to that of normal control eyes - A comparative case control descriptive pilot study

Soumyakanta Mohanty[1*], Shovna Dash[2]

[1,2]Department of Ophthalmology, Kalinga Institute of Medical Sciences and Pradyumna Bal Memorial Hospital, Bhubaneswar, Odisha, 751024, INDIA.
**Email:** godjagannath74@gmail.com

## Abstract

**Background:** To assess the angle of deviation in refractive error patients in comparison to that of normal controls. Methods - 147 participants of (10-40 years) of which 75 cases and 72 controls were evaluated for angular deviation of both eyes. The angle between both pupils and midpoint of glabella was considered. The amount of deviation, its relationship with magnitude of refractive error, type of refractive error and resultant vector was considered. Results - Patients with refractive error generally had greater angular deviation. Magnitude of refractive error was in direct relationship with magnitude of angular deviation in most cases. Anisometropic astigmatism, astigmatism, hypermetropia, myopia had angular deviation in decreasing magnitude. The resultant vector; the summation of both vectors had inverse relationship with magnitude of refractive error as well as angular deviation. Both sexes were affected; for a given amount of angular deviation, the magnitude of refractive error was found to be more in females as compared to males. Conclusion - Refractive error affects angular deviation with direct relationship in magnitude. This could determine us conditions with normal orthotropic eyes with latent disease before the manifestation of ocular morbidities. A salient and silent manifestation of ocular morbidity could be well diagnosed if routine angular deviation is assessed and monitored for evaluation, progression and follow up of refractive error as well as other ocular morbidities.

[*]**Address for Correspondence:**
Dr Soumyakanta Mohanty, Plot-287, Unit-3 Kharvelanagar Bhubaneswar, Odisha, INDIA.
**Email:** godjagannath74@gmail.com
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## INTRODUCTION

Angle is defined as the intersection of two lines at a point which is measured in degrees. Both eyes are placed in separate orbits and they make an angle to each other. This angle is not a constant numerical but varies between different individuals within certain range. Ocular angle varies pathologically due to different factors such as accommodative, refractive (high or very high) or anatomical and structural abnormalities of eye and orbit.[1] Normally the eyes are placed in the centre of orbit and they are orthotropic. Orthotropia is adominant feature in both eyes even among different individuals. Orthotropia Is the condition where in both the eyes are centrailly placed in the orbit apparently. Manifest squint or tropia are due to varied causes. Diseases of mild to moderate refractive error generally are orthotropic. Very high refractive errors lead to tropias.[2,3] So, barring tropias due to very severe pathological refractive errors and ocular diseases, the mild and moderate refractive errors are generally orthotropic. But is the angle between both eyes , in individuals with

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bilateral emmetropia and moderate ametropia with orthotropia the same. Is there a deviational (difference) abnormality in the angle between both eyes with orthotropia in emmetropia and ametropia. If present, is it more or less; and does the hidden angular deviation(latent) has any role to play in magnitude and quality of refractive error and vision; would be the focus of the study. Other parameters influencing the angle and its potential outcomes would also be studied in this experiment.

## METHODS

Our hospital based study has been approved by the institutional ethics committee according to the tenets of the declaration of Helsinki. This study was conducted for a period of one year and two months. This is a comparative case control descriptive pilot study involving individuals of both sexes of 10- 40 years of age.147 patients (74 males and 73 females) in the age group of 10-40 years were included in the study. Of the male patients, 40 were cases and 34 were control and out of females 35 were cases and 38 were controls. Refractive errors were namely myopia, hypermetropia , anisometropia and astigmatism were included. The patients were included from ophthalmology OPD. The normal control group was relatives accompanying the patients. A well informed written consent was taken prior to the study. The visual acuity was recorded after a thorough detailed history. The patients underwent visual assessment, slit lamp examination, tonometry and fundoscopy and necessary other ophthalmological evaluation. Visual acuity of 20/20(BE) of distant unaided vision and N6 (Both eyes) for near vision unaided was termed as normal. Any visual acuity less than (Distant Vision)20/20 and N6 (Near Vision) was considered abnormal. Refraction was done by a prior AR (autorefractometer) reading. Based on Auto refratometer reading a refractive correction was tried. Cases which were 20/20 and N6 (Best Corrected Visual acuity) was taken into consideration. IPD was recorded. Patients (normal control or cases) who were orthotropic were considered for evaluation. Individuals having squint (manifest) were excluded. Other ocular disease if any, anterior or posterior segment, adnexal, orbital diseases were excluded from the study. Periocular disease like sinusitis, migraine were also excluded. Any other systemic disease like (diabetes, hypertension) or any other disease were excluded. Fundus examination manifesting any abnormalities was also excluded. Cases were defined as disease of any isolated refractive error with Best corrected visual acuity of 6/6 N6 both eye with orthotropia and without any systemic or other ocular disease. Normal controls were individuals without any systemic or local ocular diseases with unaided visual acuity of 20/20 N6 both eye with orthotropia. The angle (angular deviation or angle prabha) was defined as the angle subtended by both the eyes and the glabella. Thus the point of fixation in both eyes was the pupillary centre. The midpoint between the eyebrows of both eyes (midpoint of glabella) and the pupillary centre of both eyes was taken into consideration while constructing the triangle (sashi triangle). The glabellar mid point is the highest central fixation point for both eyes together as well as the fusion of the frontal bone the nasal bridge and the orbit. They all converge at this point, thus being the ideal fixation point.

*Construction of sashi-triangle and angle (Angular deviation)*

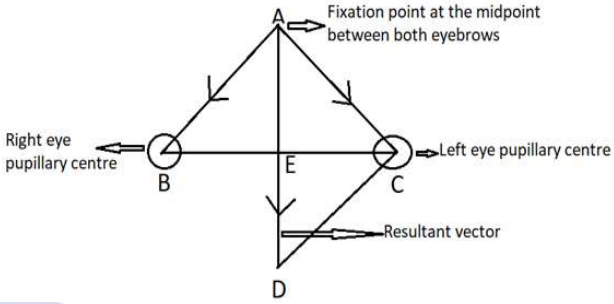


**Figure 1:**

AB = Distance from mid glabella to right eye pupillary centre
AC = Distance from mid glabella to left pupillary centre
BC = Interpupillary distance
∠BAC = Angle of Consideration
AD = Resultant Vector EC/AC = Ratio

Firstly the patient was instructed to look and fix at the distance. The centre or midpoint between both the eyebrows was marked by black ink (point A). After topically putting proparacaine eyedrops in both eyes the distance between the glabellar midpoint between both eyebrows and to right pupillary centre (AB) was recorded by the help of sterile cotton bud. The same procedure was done and recorded in the left eye(AC) also. The IPD (interpupillary distance-BC) was noted by the AR (autorefractomter) and manually. The IPD being the base the two vector arms (AB and AC) notably from the midpoint of glabella (point A) and the pupillary centre(point B and point C) , the triangle ABC(triangle SASHI) was constructed. The resultant vector (AD) was drawn starting from the apex(central midpoint between both eyebrows-point A to the termination of posterior resultant vector point D).EC\AC was the ratio of the distance between distance between midpoint of interpupillary distance to edge with that of length of one arm of triangle(triangle sashi) (Fig. 1). All the data was noted and recorded to corresponding age and sex groups. The angle was derived for both cases and controls (Both eyes unaided distant vision- 6/6, N6 unaided near vision) without any refractive errors.

## RESULTS

Deviation could be due to wide interpupillary distance, anterior or posterior placed eyeball or orbit giving rise to increased or decreased angular deviation. Similarly anterior or posterior placed glabella give rise to decreased or increased angular deviation (Fig.2).

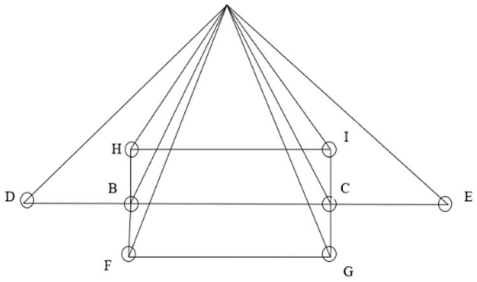


**Figure 2:** A (Midpoint of Glabella)

D,H,B,F = Different position of the pupillary centre of the right eye
E,I,C,G = Different position of the pupillary centre of the left eye
ABC = triangle formed by glabella and the pupillary centres of both eyes
BAC = normal angle of deviation
BH, CI = Anteriorly displaced eyeball Angle HAI = Increased angular deviation
BF, CG = Posteriorly displaced eyeball Angle FAG = Decreased angular deviation
BC = Normal Interpupillary distance
DE = Increased Interpupillary distance Angle DAE = Increased angular deviation

On conclusion of the study the results prove that angular deviation increase is related to increase in refractive error. The refractive error with anisometropic astigmatism, hypermetropia astigmatism ,myopic astigmatism followed by simple hypermetropia and simple myopia had magnitude of angular deviation in decreasing order. Dividing the results equally into three groups of mild ,moderate and severe angular deviation the following results were found. There was presence of increased angular deviation in refractive error cases than normal controls who had no refractive error. In cases of milder form of angular deviation there was not much significant difference in comparison to that of normal controls without refractive error. The angular deviation in the refractive error cases proves that a gradual angular deviation increase is associated with higher refractive error morbidity. But the milder group of angular deviation had similar angles to the normal control emmetropic group. So this study compares the moderate and severe form of angular deviation group with the angular deviation of the normal control population. Hence the milder group of angular deviation was excluded. Male cases showed an average angle of 122.6 ± 7.5degree in contrast to the control of 107.7 ± 8 degrees suggesting a marked difference in both groups as similar to Female cases who showed an average angle of 121.9 ± 7.4 degrees in contrast to the control (female) of 107.4 ± 7.1degrees. For the same amount of angular deviation the refractive error is more in females than that found in males. In other words for the same amount of refractive error the angular deviation was lesser in females than males. The angles were generally age independent. Both high and low angles were found in all age and gender groups. In normal control group all values of angular deviation was found within the range. Different axis degree (namely horizontal cylindrical axis in one eye vertical cylindrical axis in other eye) showed a greater deviation than axis of same degree (either horizontal or vertical cylindrical axis) in both eyes . Ratio for male cases (0.86 ± 0.04) in contrast to male controls (0.81 ± 0.04) was statistically significant. More the ratio, more the refractive error for the same amount of angular deviation. Most commonly more the ratio more the refractive error, lesser the ratio lesser the refractive error . However the ratio for females in both control and cases wasn't statistically significant. Resultant for male (the summative vector) was less (36.7 ± 5.2mm) in cases than that of controls (45.6 ± 5.6mm). This was significant. Resultant for female cases (35.7 ± 5.7mm) was less than that of controls (44.4 ± 5.3mm) which had statistical significance. Resultant vector was inversely related to the angular deviation ,with increased angular deviation there is decreased posterior vector and decreased angular deviation with increased posterior vector. Dividing the cases as moderate and severe angular deviation , the moderate angular deviaton in males had an average angle (116.6 ± 3.1) degrees compared to (128.6 ± 5.5) degrees in severe angular deviation cases. Ratio for males was (0.83 ± 0.02) for moderate to (0.89 ± 0.01) in severe cases.Resultant vector of male moderate angular deviation cases was (40.5 ± 3.21mm) compared to that of (32.9 ± 3.97mm) in severe angular deviation cases. All the male parameters between moderate and severe was statistically significant. Moderate angle of deviation (angle prabha) for female cases was (116.9 ± 6.0 degrees) as compared to (126.7 ± 5.2 degrees) in severe angular deviation cases. The resultant vector for female moderate cases were (39.5 ± 5.2mm) in comparision to (32.1 ± 3.3mm) in severe cases (Table 1). Both the parameters were statistically significant. Mostly the angular deviation correlate, but in certain cases there is an aberrant relationship with an decreased angle with increased refractive error .In very few conditions increased angle is associated with decreased refractive error. But surprisingly the ratio for females was not significant between moderate

and severe angular deviation similar like the total female cases and total female control.

**Table 1:** Ophthalmological parameters compared between cases and controlled population

| Parameters | Case (Mean ± SD) | Control (Mean ± SD) | P Value |
|---|---|---|---|
| Angle for male | 122.6 ± 7.5 degree | 107.7 ± 8.9 degree | < 0.001 |
| Ratio for Male | 0.86 ± 0.04 | 0.81 ± 0.04 | < 0.001 |
| Resultant vector for male | 36.7 ± 5.2mm | 45.6 ± 5.5mm | < 0.001 |
| Angle for female | 121.9 ± 7.4 degree | 107.4 ± 7.1 degree | < 0.001 |
| Ratio for female | 0.81 ± 0.30 | 0.81 ± 0.04 | 0.933 |
| Resultant for female | 35.7 ± 5.7mm | 44.4 ± 5.3mm | < 0.001 |
| Ophthalmological parameters compared between moderate and severe refractive error groups | | | |
| Angle for male | 116.6 ± 3.1 degree | 128.6 ± 5.5 degree | < 0.001 |
| Ratio for Male | 0.83 ± 0.02 | 0.89 ± 0.03 | < 0.001 |
| Resultant vector for male | 40.5 ± 3.24mm | 32.9 ± 3.97mm | < 0.001 |
| Angle for female | 116.9 ± 6.0 degree | 126.7 ± 5.2 degree | < 0.001 |
| Ratio for female | 0.83 ± 0.03 | 0.78 ± 0.42 | 0.597 |
| Resultant for female | 39.5 ± 5.2mm | 32.1 ± 3.3mm | < 0.001 |

## DISCUSSION

This study divides the refractive errors cases with orthotropia into three equal groups as mild angular deviation group, moderate angular deviation group and severe angular deviation group in increasing order. The mild deviation group showed statistically insignificant difference of deviation of angle in comparison with normal controls having Visual acuity 20/20 (Both eyes) and Near vision N6 (Both eyes). The mild angular deviation group with refractive error don't seem to differ than normal controls suggesting the body's mechanism to maintain the balance of orthotropia. Mostly there is increased refractive error with greater deviation. Generally refractive errors are directly proportional to angular deviation in spite of a normal orthotropic eyes. Thus it suggest that normal orthotropic eyes could imply two things namely an emmetropic eyes or eyes with refractive error. Orthotropic eyes with normal range of angular deviation shows that its mostly emmetropic. On the other hand the same orthotropic eyes could have a latent larger deviation resulting with associated refractive errors. This angular deviation is latent because inspite of a widened angular deviation the eyes are orthotropic just like emmetropic eyes. The deviaton of angle in refractive errors is larger from angular deviation of normal control eyes with orthotropia. If there could be a latent angular deviation directly proportional to refractive error, this could also lead us to understanding of other latent non-refractive ocular disease. With the same refractive error the deviation of angle is greater in males than females. So an insult to the eye will bring a notably greater visual decrease or increased refractive error in females more than that of males. Of the refractive errors the more serious are astigmatism (mixed, anisometropic, hypermetropic, myopic). The angular deviation being more serious in anisometropia than isometropia. The refractive errors with higher morbidity have a greater deviation of angle than lesser grade and morbidity. Cylindrical axis of combination of one eye vertical and other horizontal axis have more angular deviation than same cylindrical axis in both eyes. Thus, conditions with decreased form sense (astigmatism, hypermetropia, myopia) have directly influenced the angular deviation in spite of orthotropic eyes. So an orthotropic eye can hold in itself a much emerging latent ocular morbidity. This could mean angular deviation is an early sign of ocular morbidity before it goes to a more manifest disease. Thus refractive abnormality does cause angular deviation. Deviation of angle in either sex suggests that increased angle deviation is evident in ocular morbidity in both sex . Deviation is a universal phenomena affecting both sex as well as all age groups Resultant vector the summation of both diverging vectors , shows that angle is predominantly dependent on it. The greater the resultant vector the less the angular deviation and most likely lesser magnitude of refractive error. In other words an indirect relationship exists between refractive error, angular deviation and the resultant vector. Thus normal control population have greater resultant vector than abnormal or diseased group (Table 2). Refractive error is not the sole factor for angular deviation. Sometimes the refractive error could be high with a near normal angle. At the same time the refractive error may be less with an increased angular deviation. Summarizing the refractive error has in most cases a direct causal relationship with angular deviation but not the sole cause. The posterior resultant vector in almost all cases quantifies the angular deviation in inverse relationship. More the resultant vector lesser the angular deviation . So angular deviation ; a major risk factor for refractive error is

dominated by the posterior resultant vector in almost all cases . Thus angular deviation is consistently inversely dependent on summation of both diverging vectors; that is the posterior resultant vector. Thus the total resultant vector of both eyes holds in itself a unifying factor to contain the morbidity in itself. High degree of refractive error with low angle suggests an underlying mechanism by which the eye maintains its integrity at such adverse condition. This integrity has a direct relationship to the high magnitude of resultant posterior vector. Ratio is the determinant of amount of refractive error. Ratio evaluation clearly illustrates that with increased ratio there is generally associated an increased grade of refractive error. Even in cases of same degree of angular deviation there is an increased refractive error with cases who have increased ratio. Thus it proves that increased ratio is associated with increased refractive error and also generally an increased angular deviation. In rare cases we find exceptions to the observation; the reason of which is not clearly understood. In females the ratio does not hold statistical significant difference proving that within an small range of ratio difference most refractive error do occur .Thus ratio understanding could hold a prime determinant in a female with significant angular deviation ,refractive error and also focus on female orbital, ocular anatomy, psychophysiology and also feminine developmental and pathological processes. The constitutional, genetic, psychosomatic , environmental influences do play a role in the development of refractive errors.[4,5] Refractive errors have largely a direct relationship to angular deviation. Angular deviation influences the resultant vector and thus vector determination and such vector representation could be a tool to understand other ocular pathology, its pathogenesis , prognosis and good health and all round development of the eye. Angle and age relationship is mutually exclusive as found in this study. Normal population had a range of angle value ; with both higher and lower values of this range found in all age groups. Angle could be an important measure to compare and understand ocular disease and their relationship with each other. Angle being mostly a near constant variable in spite of physical, mental or structural growth of the face, orbit, eye and the brain; its deviation could affect in a major way to various structure and function of the eye, face, brain even with a little deviation. A more insight to this principle would open a Pandora box of our understanding of the psychosomatic and mental influences on the various organs and the health of an individual's ocular or generalized total heal.

**Table 2:** Examples of angular deviation posterior resultant vector and ratio relationship in different cases

| Sex/age | Spherical Cylinder Axis (diopter) (diopter) (degrees) | Resultant vector(mm) | Ratio | Angular deviation (degrees) |
|---|---|---|---|---|
| 26 yrs Male | | | | |
| RE | -0.5 -0.5 90 | 42 | 0.833 | 115 |
| LE | -1.25 -1.0 80 | | | |
| 25 yrs Male | | | | |
| RE | -1.75 -0.25 170 | 30 | 0.918 | 132 |
| LE | -1.75 -0.75 90 | | | |
| 24 yrs Female | | | | |
| RE | -1.0 -0.75 20 | 28 | 0.9 | 134 |
| LE | -1.25 -0.25 90 | | | |
| 20 yrs Female | | | | |
| RE | -2.5 -0.5 180 | 44 | 0.85 | 115 |
| LE | -2.5 -0.25 170 | | | |
| 12 years Female | | | | |
| RE | 0 -0.5 170 | 34 | 0.885 | 123 |
| LE | 0 -0.5 180 | | | |
| 19 yrs Female | | | | |
| RE | -0.5 0 0 | 34 | 0.857 | 124 |
| LE | 0 -0.25 140 | | | |
| 32 yrs Female | | | | |
| RE | -0.5 0 0 | 40 | 0.789 | 116 |
| LE | 0 -1.0 90 | | | |
| 31 yrs Female | | | | |
| RE | -1.25 -0.5 180 | 40 | 0.837 | 115 |
| LE | -1.0 -0.75 180 | | | |
| 28 yrs Male | | | | |
| RE | 0 -0.75 50 | 44 | 0.8 | 115 |
| LE | -0.50 -0.75 160 | | | |

| | | | | |
|---|---|---|---|---|
| 25 yrs Male | | | | |
| RE | -0.75 -1.0 30 | 32 | 0.891 | 128 |
| LE | -1.0 -0.75 140 | | | |

## LIMITATION OF THE STUDY

The major limitation in this study is the sample size. A still larger size would represent the wide general population. This is evident of the finding of ratio in females in which there is no significant deviation of the mean in control and cases. Getting individuals without any kind of disease (ocular or systemic) with only primary and solitary refractive error is a major limitation. Thus it needs a greater spectrum of disease inclusion and duration of study. The individuals who got enrolled should be followed up for a longer period of time for more understanding of glasses use on the angular deviation, it's progression, regression and prognosis. Similarly, normal controls of increased number would provide a wider database in this angular deviation study. The study being in local regional population, there is a need to conduct this study in a wider varied cultural, diverse population of different states and races. Study in elderly group could not be carried out due to presbyopic effects, ageing degenerations (ocular and systemic).[6] Elderly study group would unravel still more understanding of human ocular dynamics, influences pathogenesis in contrast to younger and individuals (Fig 3). Similarly, study in younger age group (0-10years) would manifest the latent mysteries of the basic ocular anatomy, physiology and the abnormalities.

## CONCLUSION

Angular deviation difference exist between normal and refractive error patients. Increased latent angular deviation definitely shows a abnormality which is related to refractive errors and probably could cause other ocular abnormalities. The angular deviations would open a wider view of understanding of morbidities of patients' health. Thus it is advised to carry out measurement of angular deviation (angle prabha) in all conditions of ocular diseases with a high degree of suspicion to aid in diagnosis , therapy, follow up and prognosis in cases of both manifest as well as latent diseases .

## REFERENCES

1. Friedman Z, Newmann E, Hyams SW, Peleg B. Opthalmic screening of 38000 children age 1 - 2 1/2 years in child welfare clinic. Journal At Paediatric Ophthalmology and Strabismus, 1980;17(4) 261-267.
2. Burian HM, Exodeviations: their classification diagnosis and treatment AJO 1966 Dec, 62(6) 1161-6.
3. Eskridge JB. Evaluation and diagnosis of incommitant outer deviations. J Am Optom Association 1989 May; 60(5) 377-88.
4. Prema R, George R, Satyamangalam R, Hemamalini A, Bhaskaran M. Comparison of Refractive Error and Factors associated with spectacles use in rural and urban South India Population, IJO 2008(Mar Apr) 56(2), 139-144.
5. Krishnaiah SP, Srinivas M, Cklama R, Rao GN. Prevelence and risk factors for refractive errors in the South Indian Population; The Andhra Pradesh Eye Disease Study Clinical Opthalmology 2009; 3:17-27.
6. Skalka HW. Comparison of Snellen acuity, VER acuity and Ardan grading scores in Macular and optic nerve disease. Br Journal of Ophthalmology, 1980 Jan: 64(1) 24-29.

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