

COMPARISON OF CORNEAL TOPOGRAPHY WITH AUTOMATED REFRACTOMETRY IN THE ASTIGMATISM OF KERATOCONUS

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ABSTRACT

BACKGROUND

Keratoconus is commonly associated with irregular myopic astigmatism. This astigmatic change is compared and analysed with the corneal topography and automated refractometry.

MATERIALS AND METHODS

35 eyes of 20 patients of keratoconus were included in the study during the period July 2017 to July 2018 at a tertiary care hospital. All were subjected to detailed anterior segment, visual acuity, keratometry, automated refractometry and corneal topography examination. The range and severity of astigmatism obtained with corneal topography and automated refractometry were compared and analysed.

RESULTS

75% of patients had bilateral and 25% had unilateral keratoconus. 50% of patients were in the age group of 10-20 years. 45% of patients were females and 55% were males. 51% of eyes had moderate K value (48-54 D). 43% of eyes had <6/60 of uncorrected visual acuity (UCVA). 74% of eyes showed higher cylindrical values in topography. 5% eyes showed some astigmatism value in both topography and automated refractometry (where the cone is present in visual axis). 85% of eyes improved after correction with spectacles. 15% did not improve with spectacles (because of high myopic astigmatism). 74% of eyes accepted lower cylinder values than revealed by corneal topography.

CONCLUSION

The assessment of astigmatism with the corneal topography shows higher values than the automated refractometry, but the acceptance of the cylinder values by the patient is good within AR values.

KEYWORDS

Keratoconus, Corneal Topography, Automated Refractometry, Astigmatism, Cylinder Values.

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BACKGROUND

Keratoconus is a non-inflammatory disease that compromises the structural integrity of the collagen matrix within the corneal stroma. The hallmark characteristic is the development of a localized cone shaped ectasia that is accompanied by thinning of the stroma in the area of the cone. This leads to increasingly irregular astigmatism as well as a steeper corneal curvature. This causes retinal image blur and poor visual acuity. It causes mild to severe loss of vision.

The incidence of keratoconus in the general population is approximately 2/100,000 (0.002%).¹ The prevalence rate of keratoconus is 54.5 per 100,000 (0.05%). It's a general rule that whatever test for keratoconus is performed in one eye it should always be done in the fellow eye.

The transparent cornea is the main structure responsible for refraction of light entering the eye. This clear transparent structure forms anterior 1/6th of the eyeball. The cornea has 5 layers.

1. The Epithelium
2. The acellular Bowman's layer
3. Corneal stroma
4. Descemet's membrane
5. Corneal endothelium

Definite aetiology is unknown. Keratoconic corneas have increased levels of numerous enzymes capable of degrading a wide variety of corneal extracellular matrix. These degradative enzymes are associated with oxidative stress. The mechanism that regulates the enzyme inhibitor interactions are not understood.

Keratoconic corneas show sign of oxidative damage. There are increased levels of inducible Nitric oxide synthase, nitrotyrosine, malondialdehyde and glutathione-S-transferase. There are lower levels of important enzymes critical for the removal of harmful oxidants like superoxide dismutase² and Aldehyde dehydrogenase class 3.

These types of antioxidant abnormalities are associated with increased levels of Superoxide radicals O₂, Hydrogen

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peroxide and hydroxyl radicals (OH) commonly referred to as Reactive Oxygen Species (ROS) and cytotoxic aldehydes. These elements react with proteins, DNA and lipids to cause alterations in the cellular structure and function of the cell.

In normal corneas the elimination of ROS and aldehyde by antioxidant and lipid peroxidation enzymes causes minimal damage to DNA protein and lipids.

Keratoconic corneas have-

- i. Oxidative and cytotoxic by-products from both lipid peroxidation and nitric oxide pathways.
- ii. Abnormalities in levels and activities for corneal antioxidant enzymes which are responsible for elimination of ROS and toxic aldehydes.
- iii. Defect in SOD gene, an antioxidant enzyme
- iv. Increased mitochondrial DNA damage

Evaluation of Astigmatism

Anterior corneal curvature is a prolate. It is not exactly spherical, since the peripheral part is substantially flatter than the central part. The central part has an average curvature of 7.8 mm.

The optical zone is nearly spherical, but keratometry shows that even in this region curvature varies in different meridians proving the apical zone to be toric. Hence the refractive system of the eye has some built in physiological astigmatism. The central optical zone is that amount of central area varying in power not more than 1 diopter differences. This average value is about 4 mm.

Corneal Topography

Corneal topography measures the shape or curvature of the anterior corneal surface.

Automated Refractometer

Refraction, being the most commonly performed optical procedure, has been widely developed. Though the conventional technique of Retinoscopic Refraction is an excellent method, it is time consuming. Alternate method of finding out the Error of Refraction by the use of an optical equipment called Refractometer or Optometer is in use in the modern practice.

Objectives of the Study

- To compare the astigmatism in keratoconus patients by corneal topography and automated refractometry
- To assess the astigmatism in the visual axis in comparison with the position of the cone

Inclusion Criteria

- Patients with clinical features of keratoconus
- In keratometry: dioptric power more than 45D
- Corneal topographically confirmed cases
- In refraction: patients with irregular astigmatism.

Exclusion Criteria

- Patients with the history of corneal injury
- History of previous ocular surgery

MATERIALS AND METHODS

The study was conducted at regional institute of ophthalmology and govt ophthalmic hospital Chennai between July 2017 and July 2018. It is a retrospective study.

35 eyes of 20 patients were included in the study. The patients underwent estimation of uncorrected visual acuity, keratometry, topography, automated refractometry and subjective refraction initially. A detailed ocular and slit lamp examination were performed. The parameters obtained from topography and automated refractometry were analysed and the cylinder values were compared. The acceptance with the cylinder values derived from topography and automated refractometry were recorded in 35 eyes. The patients best corrected visual acuity was recorded. In unilateral presentation of 5 cases the other eye V/A, K reading, topography values were analysed to rule out forme fruste type of keratoconus.

RESULTS

The results were analysed as follows-

Laterality

Keratoconus is a bilateral condition. It starts in one eye at the time of onset. Among 20 patients in the study 5 had unilateral and 15 had bilateral presentation. In unilateral cases, the other eye V/A in all 5 eyes was 6/9, K reading value <45D and topographically also the PRK value <90%.

Unilateral	5 Patients
Bilateral	15 Patients

Table 1

Gender Distribution

The incidence of keratoconus is greater in males than in females. In our study group of 20 patients 11 were males³ and 9 females.

Males	11 Patients
Females	9 Patients

Table 2

Age of Presentation

Keratoconus commonly presents during the second decade of life.⁴

Less Than 10 Years	Nil
10-20 Years	10 Patients
20 -30 Years	9 Patients
>30 Years	1 Patient

Table 3

In this study no patients were below the age of 10. There were 10 patients in the age group between 10-20 yrs, 9 patients in the age group of 20-30 years and 1 patient more than 30 years of age.

Keratometry

Based on keratometry reading the 35 eyes presenting with keratoconus were graded as mild, moderate and severe.⁵

Mild	<48 D	9 Eyes
Moderate	48-54 D	18 Eyes
Severe	>54 D	8 Eyes

Table 4

Uncorrected Visual Acuity

Based on uncorrected visual acuity 35 eyes of 20 patients were grouped in to 3 groups.

In group 1 the uncorrected visual acuity was less than 6/60 and 15 eyes were classified into this group.

In group 2 UCVA ranged between 6/60 and 6/24 13 eyes were classified into this group.

In group 3 the UCVA range was between 6/18 and 6/12.7 eyes were classified in this group.

Analysis of Group 1

There were fifteen eyes in group 1. Their AR and topography cylinder values were compared.

Topographic values were higher than AR in 11 eyes, same as AR in 2 eyes, less than AR in 2 eyes.

Visual correction was done with glasses based on AR cylinder values in all 15 eyes. 14 eyes showed visual improvement, in 1 eye no improvement because of corneal opacity. The details of cylinder values are shown in tabular column.

Cylinder	No. of Eyes	Visual Improvement
-3 to -6.5	8 Eyes	6/60-4 6/18-2 6/12-2
-7 to -8.5	3 Eyes	6/60-1 6/36-1 6/24-1
-9 to -11	3 Eyes	6/60-3
	1 Eye	No Improvement

Table 5

Analysis of Group 2

13 eyes were in this group. Topographic cylinder values were higher than AR in 10 eyes, same as AR in 3 eyes.

Visual correction was done with glasses based on AR values and details shown in tabular column.

Cylinder	No. of Eyes	Visual Improvement
-1.5 to -4	8 Eyes	6/12-4 6/9-2 6/6-2
-4.5 to -6	2 Eyes	6/12-2
-6.5 to -8	Nil	-
-8.5 to -11	3 Eyes	6/24-1 No Improvement- 2

Table 6

Analysis of Group 3

7 eyes come in this group. Topographic cylinder values were higher than AR in 5 eyes, lower than AR in 2 eyes. The details of the glass correction in this group are shown in tabular column.

Cylinder	No. of Eyes	Visual Improvement
-1.0 to -3.0	3 Eyes	6/6-3
-3.5 to -6.5	2 Eyes	6/9-2
	2 Eyes	No Improvement

Table 7

High Myopia

10 out of 35 eyes presented with high myopia. The spherical dioptric power ranged from -5.0 D to -18 D. High myopia with astigmatism was difficult to correct with glass alone.

-5 to -6 D	5 Eyes
-9 D	2 Eyes
-10 D	1 Eye
-13.5 D	1 Eye
-18 D	1 Eye

Table 8

Best Corrected Visual Acuity

The 35 eyes were grouped into 4 groups, with respect to V/A ranging.

<6/60	Nil
6/60-6/24	11 Eyes
6/18-6/12	10 Eyes
>6/12	9 Eyes
No Improvement	5 Eyes

Table 9

Comparing the astigmatism between topography and subjective values.⁶

26 out of 35 eyes had higher cylinder values in corneal topography when compared to automated refractometry subjective values.⁷

5 eyes had same cylinder values in both methods.

4 eyes had higher cylinder values in AR.

Comparing the distance of cone from the papillary axis:

>0 to 1 mm-7 eyes

>1-2 mm- 10 eyes

>2 mm- 13 eyes

In this study, bilateral presentation was more than unilateral. 75% of the patients presented with bilateral keratoconus and only 25% presented unilaterally.

- A majority 50% of the patients were in the age group of 10- 20 year.
- 45% females and 55% males were affected among the study group.
- Majority of the eyes 51% had moderate grade of k values (48-54)
- The uncorrected visual acuity was <6/60 in 43% of cases.

- Comparing the astigmatism between corneal topography⁸ and automated refractometry, 26 out of 35 eyes (74%) showed higher cylinders value in topography reading. 5 eyes had same values and in 4 eyes their value was higher.
- In 5 eyes, where the cone was present in the centre, the automated refractometry and corneal topographic cylinder values were found to be the same. In the remaining 30 eyes, where the cone was not at the centre, the cylinder values were different.
- Overall 85% (30 out of 35 eyes) improved after correction with spectacles. 5 out of 35 eyes (15%) did not improve with spectacles, because of high myopic astigmatism.
- 26 out of 35 eyes (74%) accepted lower cylinder than revealed by corneal topography.

DISCUSSION

Keratoconus presents as irregular myopic astigmatism. In irregular astigmatism the curvature of the cornea is different in various meridians, and no geometrical pattern is adhered. Corneal topography used in this study is based on the principle of the Placido disc.⁹ In astigmatism Topography displays the difference in curvature of two principal corneal meridians as a bowtie pattern.

Two essential factors are involved in keratoconus screening and assessment.

1. First is to evaluate the asymmetry and irregularity of the contour pattern
2. Second is to evaluate the range and magnitude of curvature that is present in the pattern.

The colour coded topographic maps permit a more detailed evaluation of the corneal contour. This technique is useful for detecting corneal irregularities in the early stage of keratoconus and may identify patients who do not have slit lamp evidence of the disease.

Keratoconic topographic alterations can be of two types-

1. In the first type 75% changes are peripheral, with steeping of corneal contour extending to the limbus. The apex of the cone, defined as the point of maximal power, frequently does not correspond to the geometric centre of the steepest area.
2. In the second group, 25% steepening is confirmed primarily to the central cornea, with relative sparing of the peri-limbal area.

Corneal topographic analysis is important in diagnosing and also to know the overall contour of the cornea. When comparing the cylinder values are obtained from the Topography and Automated Refractometry subjective, the cylinder values obtained from topography is always high.

This is because, it covers the whole cornea and also the eccentric presentation of the cone.

In Automated Refractometry reading, the central 4mm of the cornea is taken. The cylinder values are normally less, unless the cone is present in the centre.

The advantage of Topography is that, even mild forms can be detected at an earlier stage.

The patient accepts the cylinder values of Automated Refractometry¹⁰ better than the topography.

CONCLUSION

This study clearly demonstrates that the corneal topographic assessment of astigmatism shows higher values, which are not acceptable to the patients.

Astigmatism correction with automated refractometry derived cylindrical values, were accepted well by the study group. This is probably because the cylindrical value assessed by corneal topography is confounded by the position of the cone with reference to the visual axis, whereas that obtained by AR is the one that is at the visual axis.

This proves the usefulness of automated refractometry in astigmatism correction in keratoconus, even though corneal topography has the advantages of early detection of this condition.

In centres where a video-keratoscope is not available, the AR machine can be used for visual rehabilitation.

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