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Effect of Cyclopentolate Hydrochloride 1% on Corneal Curvature in Keratoconus

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Abstract

Objectives: The objective of current study is to check the effect of cyclopentolate hydrochloride 1% on corneal curvature in subjects with keratoconus.

Methodology: This comparative cross-sectional study was conducted at Ophthalmology Department of The University of Lahore Teaching Hospital in the duration of 6 month. 70 subjects of either sex with keratoconus without any pathology were selected for this study. Informed consent was taken from every individual prior to their inclusion in the study. Non-probability random convenient sampling technique was used to collect the data. After the history taking retinoscopy and subjective refraction was performed to determine the type and degree of refractive error. After that a complete ocular examination was done to rule out the subjects with keratoconus. Then the corneal curvature of each subject was measured before and after the instillation of cyclopentolate hydrochloride 1%.

Results: A total 70 subjects having different categories of keratoconus (Mild, moderate and severe) from the age ranged $12-30$ were included in this study. There were 46(65.71%) females and 24 (34.3%) males. The frequency of subjects with Mild Keratoconus was 18 (25.7%), with moderate keratoconus was 32 (45.7%) and with severe keratoconus was 20(28.6%) respectively. The mean and S.D of K1 before and after cyclopentolate was 52.86±3.549 and K2 before and after cyclopentolate was 54.61 ± 4.32 and 54.23 ± 4.53

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respectively. The results showed the significant association of cyclopentolate before and after the instillation.

Conclusion: The study results conclude that there was a significant association of cyclopentolate on corneal curvature before and after instillation of drop. Cyclopentolate hydrochloride 1% induced flattening of corneal curvature.

Keywords: Corneal Curvature, Corneal ectasia, Cyclopentolate hydrochloride 1%, Keratoconus.

Introduction

The refractive state of the eye is determined by refractive components (corneal power, lens power, anterior chamber depth, and axial length) which are interdependent rather than independent variables, and that the eye grows during the early years in life in such a manner that the refractive state tends towards emmetropia[1]. The refractive state of the human eye is dependent on the balance of change in overall eye size and refractive components, namely, the cornea and crystalline lens[2]. The axial length (AL) is the distance from the corneal surface to an interference peak corresponding to the retinal pigment epithelium/Bruch's membrane and this is expressed in millimeters[3]. Majority of eye growth takes place in the first 18 months of life after which there is little change[4]. Overall, the changes in axial length appear to outweigh the progressive corneal flattening with age in normal eyes; the majority of axial length elongation takes place in the first three to 6 months of life and a gradual reducing rate of growth over the next two years and by three years the adult eye size is attained[5]. The cornea is the most powerful refracting surface of the optical system of the eye, accounting for two-thirds of the eye's focusing power[6].

Corneal curvature and thickness, anterior chamber depth, and refraction are important factors that are used for calculations and planning many ophthalmic procedures, including cataract and refractive surgeries. Cycloplegic refraction is also frequently required in certain patient populations, such as hyperopic patients and children[7].

Knowledge of corneal curvature is primarily of interest as an aid in determining the initial contact lens to be placed on the eye in cases of rigid contact lens fitting. In addition, an indication of rapid changes in curvature can be indicative of a compromised cornea and also aid in the diagnosis of keratoconus[8].

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Keratoconus is a non-inflammatory, progressive thinning process of the cornea. It is a relatively common disorder of unknown etiology that can involve each layer of the cornea and often leads to high myopia and astigmatism[9]. Computer- assisted corneal topography devices are valuable diagnostic tools for the diagnosis of subclinical keratoconus and for tracking the progression of the disease[10]. The traditional conservative management of keratoconus begins with spectacle correction and contacts lenses[11]. Several newer, more invasive, treatments are currently available, especially for contact lens-intolerant patients[12]. Intrastromal corneal ring segments can be used to reshape the abnormal cornea to improve the topographic abnormalities and visual acuity[13]. Phakic intraocular lenses such as iris-fixated, angle-supported, posterior chamber implantable collamer and toric lenses are additional valuable options for the correction of refractive error[14]. Corneal cross-linking is a relatively new method of stiffening the cornea to halt the progression of the disease. The future management of keratoconus will most likely incorporate multiple treatment modalities, both simultaneous and sequential, for the prevention and treatment of this disease[15].
The hereditary pattern is not predictable although the strongest evidence of genetic involvement is a high concordance rate in monozygotic twins. A positive family history has been reported in $6-8\%$ of the cases and its prevalence in first-degree relatives is $15-67$-times higher than the general population[16].

Materials and Methods

This comparative cross-sectional clinical study was conducted at outpatient Department of Ophthalmology, The University of Lahore Teaching Hospital, Lahore in duration of 6 month from Sep 2021- Feb 2022. Ethical approval was obtained by ethical and scrutiny review board of The University of Lahore to conduct the research. Both eyes of 70 subjects of both genders were included in the study from the age ranges $12-30$ years through non-probability convenient sampling technique. All the patient with keratoconus of varying degree without any past surgical intervention or current systemic infection were included in the study. A self-designed Proforma was used to record data about the demographic information, grade of keratoconus and mean keratometric reading before and after instillation of cyclopentolate hydrochloride 1%. The keratoconus subject was categorized according to corneal curvature as mild ($< 48D$), moderate ($48-54D$) and severe ($> 54\ D$).

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After explaining all the procedure to the patients both verbal and written informed consent was taken from all the subjects who were part of the study. Preliminary a complete ocular examination was performed to rule out the keratoconus and to exclude all other ocular pathologies after recording the detailed history. A visual acuity of each subject was recorded with the help of LED Snellen chart at a distance of 6 meter. After the visual acuity measurement retinoscopy and subjective refraction were performed to determine the type and degree of refractive error. After obtaining the results about type and degree of refractive error corneal curvature was measured with the help of autorefractor keratometer before and after the instillation of cyclopentolate hydrochloride 1%. Prior to instillation of drop corneal curvature was measured initially after that one drop of cyclopentolate hydrochloride 1% was instilled in both eyes 3 time at 15 mints of interval. After 45 minutes of instillation from the last drop corneal curvature was measured again to evaluate the post cycloplegic changes in corneal curvature.

Data was analyzed through SPSS (statistical package for the social science) programming software version 25. Descriptive statistics was applied to analyze the effect on mean corneal curvature readings before and after the instillation of cyclopentolate hydrochloride 1%. Paired sample t-test was used to analyzed the effect of cyclopentolate hydrochloride 1% on corneal curvature (p value <0.05 was taken as significant).

Results

A total number of 70 subjects having keratoconus were included in this study from age ranges $12-30$ years which were divided into 2 groups. Group 1 ($12-20$ years) consisting of 42 (60%) subjects and Group 2 ($21-30$ years) consist of 28 (40%) subjects. There was 46 (65.71%) females and 24 (34.3%) males as shown in Figure 1.

Keratoconus subjects was graded as Mild, moderate and severe. Out of 70 subjects 18 (25.7%) had mild keratoconus, 32 (45.7%) subjects had moderate and 20 (28.6%) had severe keratoconus reported in Table 1.

The mean and standard deviation of K1 before and after cyclopentolate hydrochloride was 52.86 ± 3.549 and 52.64 ± 3.529 respectively. Similarly, the mean and standard deviation of K2 before and after cyclopentolate was 54.61 ± 4.32 and 54.23 ± 4.53 respectively. The Paired sample t test was used to analyzed the data. It showed the significant association for both K1

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($P < 0.01$) and K2 ($p - 0.02$) before and after cyclopentolate hydrochloride 1% reported in Table 2.

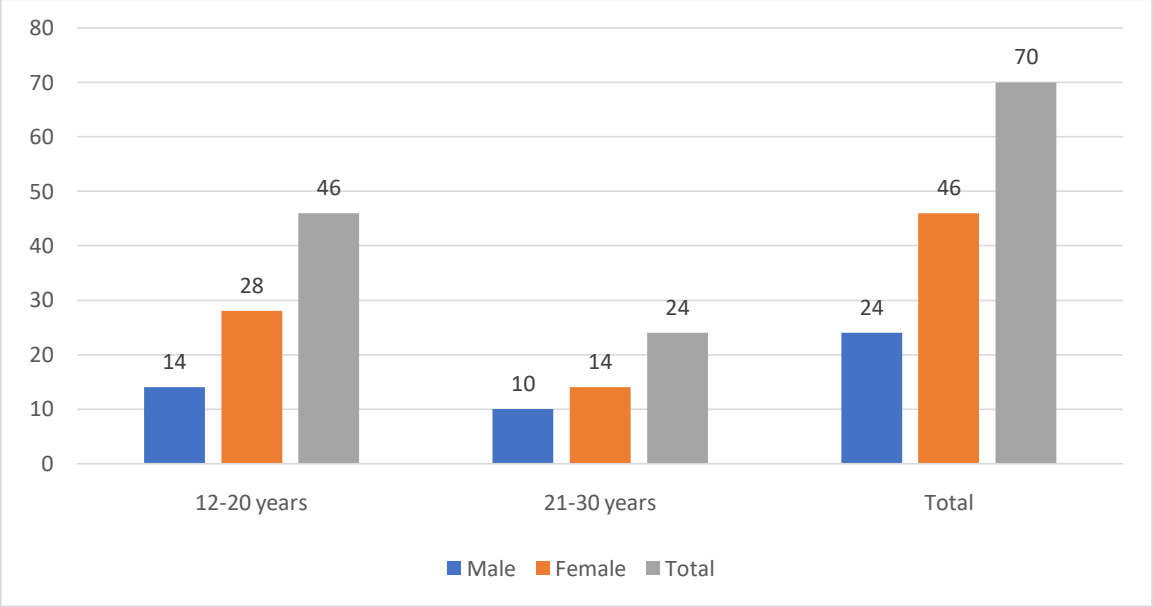

Figure 1. No. of Subjects in each Age Group

Table 1. Frequency distribution of Keratoconus

Grades of Keratoconus	Frequency	Percentages
Mild (<48 D)	18	25.7%
Moderate (48-54 D)	32	45.7%
Severe (>54 D)	20	28.6%
Total	70	100%

Table 2. Descriptive statistics before and after Cyclopentolate (n=70)

Corneal Curvature	Mean ±S. D	P-value
K1 before Cyclopentolate	52.86±3.549	0.01
K1 after Cyclopentolate	52.64±3.529	
K2 before cyclopentolate	54.61±4.32	0.001
K2 after cyclopentolate	54.23±4.53	

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Discussions

Keratoconus is a bilateral non-inflammatory and progressive corneal ectatic disorder that involves the central two-thirds of the cornea1. It is typical cone-like steepening of the cornea leading to irregular astigmatism, significant loss of vision and impairment of visual function[17]. The etiology of keratoconus is unknown that can affect each layer of cornea and leads to high myopia and astigmatism[18]. In keratoconus the curvature of the cornea is asymmetrical and the assessment of the corneal curvature is necessary to identify the progression of disease. With keratoconus progression the curvature of the cornea become steeper. Corneal curvature is the clinical variables most commonly used to monitor change in disease severity in keratoconus[19].

A comparative cross sectional was conducted in Madinah Teaching Hospital included 150 subject of age ranges from $15-30$ years. The result of this study reveals a statistically significant relationship between the horizontal meridian of corneal curvature ($p < 0.005$) before and after cycloplegia. However, there is no significant change in vertical meridian of corneal curvature before and after cycloplegia. So, study concluded that cycloplegia induce decrease in axial length and increased in horizontal meridian of corneal curvature[5]. The result of this current study reveals that there is statistically significant association of both horizontal and vertical meridian before and after cycloplegia[20].

Another study was conducted to rule out the effect of cycloplegic drugs on K-reading in keratoconus patients. Two groups were defined one control group and other having keratoconus. Keratometry parameters were checked before and after cycloplegia. Age group was 12-35 years. Whole group gone through an eye assessment. Cyclopentolate hydrochloride 1% was instilled to attained cycloplegia. The result showed that K1 and K2 values are statistically significant. It was concluded that by instilling cycloplegic drugs, cornea shows flatness in keratoconus group. And in comparison, control group showed no change in keratometric readings[21].

Another twin study was performed to rule out the changes in corneal curvature after using cycloplegia. Corneal curvature was observed pre and post instillation of tropicamide. Statistically significant flattening was observed in curvature[22].

A contrast study was also informed by Megwas in which he observed the effect of corneal curvature on different refractive errors. In this prospective study, all subjects were undergone an eye examination. Age group was 18-20 years. Subject having myopia, hypermetropia as well as emmetropia were included. They evaluated the corneal curvature as well as maximum, minimum

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and mean radius of curvature with different time of duration. And result showed that change in mean value were $P\ 0.99 > 0.05$[23].

Another study was conduct to see the effect of cycloplegic drugs on anterior segments and biometric parameters. Sample size include 42 patients with 28 females and 18 males with age limit of $23 - 58$ years. While using three different devices, a pentacam, keratometer and IOL master. They evaluate K- reading in pre and post cycloplegics. Results shows no statistically difference[24].

This study will be helpful in understanding the pre and post cycloplegic curvatural changes. It will highlight the importance of assessing corneal curvature as it has vital role in performing different ocular procedure for example Refractive surgeries.

Conclusion

The study results conclude that there was a significant association of cyclopentolate on corneal curvature before and after instillation of drop. Cyclopentolate hydrochloride 1% induced flattening of corneal curvature. Therefore, accuracy of corneal measurement is most important for optical outcomes before and after refractive surgeries.

Limitations and Future Studies

The sample size of the study was short. Future studies should be conducted to determine the effect of other cycloplegic drugs on biometric parameters or with different concentration of cycloplegic drugs.

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