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Corneal Endothelial Cell Count in Different Refractive Errors

Hussain A[1]*, Ruhullah[2], Ali S[3], Kazmi SZ[1] and Ali M[1]

[1]Optometrist, COAVS, King Edward Medical University, Pakistan
[2]MPhil Optometry, COAVS, King Edward Medical University, Pakistan
[3]Glaucoma Specialists at Mayo Hospital, COAVS, King Edward Medical University, Pakistan

***Corresponding author:** Ather Hussain, Optometrist, COAVS, King Edward Medical University, Gujjar boys Hostel, Nabha road, anarkali, Lahore, Pakistan, Tel: +923435544078; Email: hyaatather977@gmail.com

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Abstract

Objective: To assess corneal endothelial cell density in individuals having different refractive errors including Myopia, Hyperopia, and Astigmatism.

Method: A descriptive cross-sectional study was done to assess the endothelial cell count of the cornea in different refractive errors using a Performa. Data from 71 individuals (24 myopes, 24 hyperopes, and 23 astigmatic) with different refractive errors were taken using a non-contact specular microscope (Topcon SP2000P, Tokyo, Japan). Visual acuity was recorded on the Snellen chart and then both subjective and objective refractions were done to find the best corrected visual acuity (BCVA). An objective refraction was done using an auto refractometer and then was verified by subjective refraction. Patients with contact lens usage history, previous ocular surgery history, and ocular pathologies were excluded. Data was entered and analyzed with SPSS-25.

Results: The mean of endothelial cell density (ECD) between the three groups was compared. There was a difference in means values of ECD among three groups i.e., myopes, hyperopes, and astigmatic but no significant differences in ECD between myopic, hyperopic, and astigmatic eyes were found (p=0.121(RE) and p=0.106 (LE); 1-way ANOVA test).

Conclusion: It is concluded from the study that Endothelial cell density (ECD) is not associated with the three main type of refractive errors that is myopia, hyperopia and astigmatism, as we found difference in mean ECDs in these groups but this difference was not significant.

Keywords: Myopia; Hyperopia; Astigmatism; Endothelial Cell Count; Endothelial Cell Density

Introduction

The cornea is a highly transparent layer that makes up the anterior portion of the eye's outer layer. It is continuous with the sclera layer, the other layer that makes up the outer layer [1]. The cornea is one of the body's most delicate and well-innervated tissues. The nasociliary branch of the trigeminal nerve's first division, which controls vision, is where the sensation originates. The aqueous humour is the cornea's primary nourishment supply. The aqueous humour and tear film, as well as end branches of the face and ophthalmic arteries, feed components to the tiny vessels near the cornea's edge as well as blood. The cornea's horizontal and vertical diameters are 11-12 mm and 9-11 mm, respectively.

The average corneal diameter was found to be 11.71 ± 0.42 mm utilizing the ORBSCAN II system. Males and females had average corneal diameters of 11.77± 0.37 and 11.64 0.47, respectively, with ranges of 11.04-12.50 and 10.7-12.58 [2]. A healthy cornea is of great importance in maintaining the clarity of vision [3].

The cornea's deepest layer is called the corneal endothelium. It is a hexagonal, non-replicating neural crest tissue that keeps the stroma in a proper state of dehydration and pumps extra fluid out of the stroma to maintain corneal clarity throughout life [4]. It is a monolayer that, when viewed from the back, resembles a honeycomb mosaic. During the early stages of development, a monolayer of cuboidal cells from the neural crest is organized in a layer on the posterior surface. Overgrowth, the individual cells continue to flatten, stabilizing at an adult thickness of about 4μ. Along the lateral boundaries of neighboring cells, there are gap junctions and tight junctions as well as substantial lateral interdigitations. Endothelial cell density (ECD) changes from the second to the eighth decade of life. Hexagonal cell density (ECD) decreases from 3000 to 4000 cells/mm^2 to roughly 2600 cells/mm^2, dropping from roughly 75% to 60%. ECD is 3500 cells/mm^2 at birth. In normal corneas, human central ECD declines at a rate of 0.6% annually throughout adulthood, with a corresponding increase in polymegathism and pleomorphism. Recently, a deep corneal layer has drawn attention [2].

The minimum (critical) endothelial cell density (ECD) mandatory to preserve the pumping function of the endothelium is 400-500 cells/mm^2. ECD less than this critical value cause decreased corneal transparency, corneal edema development, and reduction in visual acuity [5]. ECD declines with age, trauma, intraocular surgery, refractive surgery, glaucoma, corneal dystrophies, and diabetes mellitus, it is now well-established [3]. Endothelial cell density, polymorphism (or the coefficient of variation), and pleomorphism (or hexagon coefficient, or the proportion of hexagonal cells to the total number of cells) quantitatively characterize the state of the endothelial cell. The human corneal endothelium layer can be imaged non-invasively using confocal microscopy and specular imaging in vivo, from which morphometric parameters and density can be calculated [6]. The cornea is an essential portion of the eye that is involved in the optical system of the eye and it enables optimum visual acuity. Visual acuity depends not only on the cornea itself but also on other factors including pathological state of the eye and refractive error [7].

The ability of the human eye to focus parallel light rays onto the retina during relaxed accommodation is called emmetropia. However, if the optical system of the eye fails to do so, the eye becomes ametropic, resulting in myopia, hyperopia, or astigmatism [8]. Refractive error is one of the most prevalent eye disorders that affect people of all ages. Uncorrected refractive error is the biggest threat to public health, despite the fact that there is a practical solution to the issue. Uncorrected refractive error ranks first globally for vision impairment and second globally for blindness in developing nations. Globally, it was estimated that uncorrected refractive error cost the economy $269 billion in lost productivity. The prevalence of myopia and hyperopia was 27.7% and 22.9%, respectively, whereas RE of at least 0.50 D of spherical equivalent ametropia was 53.1. Uncorrected refractive error was more common than average (10.2%), however there was a huge variety in these estimations [9].

The capacity of the cornea to maintain its dry state is one of its primary properties that make it important optically. Numerous factors, among which corneal endothelial cell count and morphology play a significant role, might lead to and maintain this corneal dehydration. The corneal endothelial cell count, one of the corneal features taken into consideration in this study, is incredibly changeable, and alterations are observed even with minor modifications to the anterior segment or larger structural changes to the eyes [10].

Materials and Methods

A descriptive cross-sectional study was done to assess the endothelial cell count of the cornea in different refractive errors using a Performa. The proforma used in this study was self-designed based on guidelines from similar studies and was reviewed by an ophthalmology expert. The sample size was calculated using $n = \frac{z_1 - - P'1 - P'}{d^2}$ with a confidence level of 95%, and 10% level of precision. Data of 71 individuals (24 myopes, 24 hyperopes, and 23 astigmatic) with different refractive errors were taken using a non-contact specular microscope (Topcon SP2000P, Tokyo, Japan). Visual acuity was recorded on the Snellen chart and then both subjective and objective refractions were done to find the best corrected visual acuity (BCVA). An objective refraction was done using an autorefractometer and then was verified by subjective refraction. Patients with contact lens usage history, previous ocular surgery history, and ocular pathologies were excluded. Data was entered and analyzed with SPSS-25.

Results

The mean of endothelial cell density (ECD) between the three groups was compared. There was a difference in means values of ECD among three groups i.e., myopes, hyperopes, and astigmatic but no significant differences in ECD between myopic, hyperopic, and astigmatic eyes. A one-way ANOVA

test was performed to compare the mean endothelial cell density (ECD) among the three refractive error groups: myopic, hyperopic, and astigmatic. The test showed no statistically significant differences in ECD among the groups (p = 0.121 for the right eye and p = 0.106 for the left eye (Table 1).

(A)

		N	Mean	Std. Deviation
endothelial cell density in cells/mm2 in RE	simple myopic	24	2583.2	±315.836
	simple hyperopic	24	2651.9	±170.634
	astigmatic	23	2514.7	±147.553
	Total	71	2584.2	±228.786
endothelial cell density in cells/mm2 in LE	simple myopic	24	2625	±304.478
	simple hyperopic	24	2662.8	±164.027
	astigmatic	23	2532	±126.572
	Total	71	2607.6	±217.632

(B)

		Sig.
endothelial cell density in cells/mm2 in RE	Between Groups	0.12
endothelial cell density in cells/mm2 in LE	Between Groups	0.11

Table 1: Comparison of mean endothelial cell density values among myopes, hyperopes and astigmatic individuals.

A one-way ANOVA test was performed to compare the mean endothelial cell density (ECD) among the three refractive error groups: myopic, hyperopic, and astigmatic. The test showed no statistically significant differences in ECD among the groups (p = 0.121 for the right eye and p =0.106 for the left eye).

Discussion

This study explored the association between three main types of refractive error i.e., myopia, hyperopia and astigmatism and Corneal endothelial cell count/density in individuals visiting Eye ward, Mayo Hospital Lahore. The link between corneal endothelial cell density, morphology, and refractive error has not been extensively studied. Despite a variety of findings, there have been noticeable alterations in corneal endothelium properties. The corneal endothelial features of various refraction errors vary [11].

One of the subjects that have received the greatest attention is the fluctuation of corneal characteristics, primarily endothelial cell density, in different refractive error groups. The anterior corneal surface topography does not considerably differ from its posterior side and has very slight comparative asphericity in myopic patients, despite greater steepening. Additionally, it is well- known that corneal curvature varies with the evolution of myopia or hyperopia, and there is almost always an excessively high link between changes in refractive error, corneal curvature changes, and axial length expansion [9]. We compared the mean values of endothelial cell density (ECD). The lowest endothelial cell density was found in astigmatic individuals then comes myopia following hyperopia, but we didn't find any significant difference in ECD values in these groups. A recent study took place also found no significant difference in ECD between emmetropia, myopia, and hyperopia groups. They used non-contact specular microscopy to examine emmetropic, myopic, and hyperopic Caucasian patients, and they found no discernible variations in ECD between them [12]. Previous studies found that corneal endothelial cell density is decreased in myopic especially high myopic individuals. Decisions regarding corneal endothelial cell changes in individuals with different types or degrees of refractive error should be based on normative data derived from the underly population. On the contrary, our study has shown no significant effect of myopia on ECD compared to other refractive errors, although we didn't categorize myopia into low, moderate, and high [4]. Our findings match with the findings of another study where the effect of spherical refractive errors on ECD was analyzed. They also found no significant effect of hyperopia on ECD while they found a significant decrease in ECD in individuals with increasing myopia [13].

Conclusion

The mean Endothelial cell density (ECD) was not much affected by the three main types of refractive errors that is

myopia, hyperopia, and astigmatism as we found a difference in mean ECDs between these groups, although this difference was not significant.

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