RESEARCH PAPER

Evaluation Of Corneal Endothelial Cell Density In Myopic Patients Of Different Age Groups

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Abstract

Background

Myopia is a growing refractive defect that is rapidly becoming widespread in all parts of the world and is usually related to structural and biomechanical changes of the eye. The corneal endothelium is a non-regenerative, essential monolayer with the role of preserving corneal transparency due to its two functions: pumping and barrier. Denser endothelial cells (ECD) are physiologically known to decrease with age, and myopic eyes, especially those that are axially elongated, could have another endothelial susceptibility, which has significant consequences on refractive and intraocular surgeries (Bourne, 2003; Joyce, 2012).

Aim

To assess the density of endothelial cells in the cornea and its change as people age in patients with myopia.

Methods

The 50 patients (100 eyes) participating in the study were myopic patients who were aged 18-50 years and participated in a tertiary eye care center. The sample was divided into three age brackets (18- 30 years, 31-40 years and 41- 50 years). The parameters of endothelial cells such as endothelial cell density (ECD) and average cell area (ACA) were measured with non-contact specular microscopy. Individuals who had undergone previous ocular surgery, uses contact lens, corneal pathology or systemic diseases that impacted the cornea were excluded. One-way ANOVA and the Pearson correlation coefficient were used to statistically analyze the data and a p value less than 0.05 was regarded as a significant difference.

Results

There was progressive deterioration in the mean endothelial cell density with age. The maximum ECD was found in the 18-30 year group, then the 31-40 years group and the lowest values were recorded in the 41-50 years older patients. They were statistically significantly negatively correlated between age and ECD ($p < 0.01$), and positively correlated between average cell area and age ($p < 0.01$), which means that there is compensatory endothelial cell enlargement as age increases.

Conclusion

The density of endothelial cells of the cornea declines with age in myopic patients with a corresponding rise in the average cell area. These results highlight the need of regular preoperative endothelial monitoring in myopic patients, especially the aged of above 40 years as a preventive measure in ensuring that postoperative endothelial decompensation during intraocular and refractive surgery is minimized.

Keywords: Myopia; Corneal Endothelial Cell Density; Specular Microscopy; Aging

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3. Introduction

3.1 Global Burden of Myopia

The problem of myopia has become one of the major world health issues because of its rapidly growing rate

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of prevalence in all age groups. It has been found through recent epidemiological studies that myopia has grown dramatically, especially among populations in East and South Asia, due to the shift in lifestyles, more near-work activities, and less outdoor exposure (Morgan et al., 2018). It has been projected that by 2050, about half of the world population will be myopic and around 10 per cent will have high myopia that endangers ocular complications that could impair vision (Holden et al., 2016).

Clinically, myopia ceases to be considered as a non-pathological refractive error. The structural changes that are correlated with progressive myopia include axial elongation, posterior staphyloma, retinal degeneration, glaucoma and cataract. Such alterations not only influence the visual function but also make it difficult to make decisions during surgery, especially when it comes to refractive or intraocular operations, which underlines the importance of comprehensive ocular examination in addition to refractive correction (Morgan et al., 2018).

3.2 Corneal Endothelium: Anatomy and Physiology.

The corneal endothelium is a single layer of hexagonal cells lining the back of the cornea which is very important in ensuring that the cornea is transparent. These cells control stromal hydration by active ionic pump mechanisms and act as a blockage of undue ingress of fluid by the aqueous humor (Bourne, 2003).

The major feature of the corneal endothelium is that it has a low regenerative potential in vivo. Under normal physiological conditions, endothelial cells do not divide but instead, cellular enlargement and rearrangement compensates the loss of cells instead of cell proliferation (Joyce, 2012). A decrease in endothelial cell density (ECD) of more than 20 per cent can destabilize the corneal deturgescence resulting to corneal edema, loss of visual acuity and in extreme cases endothelial decompensation.

3.3 Aging Endothelial Alterations.

Corneal endothelial cell density reduces slowly over time together with physiological aging. Long-term and cross-sectional studies have identified an average of 0.3-0.6 percent of endothelial cell loss per year in normal eyes (Laing et al., 1976). The cells surviving the loss of endothelial cells enlarge to compensate the loss of Descemet coverage, which leads to growth in average area of the cells and intra-cellular variability, or polymegathism (Rao et al., 1984).

These morphological alterations are believed to be compensatory alterations that maintain the normal corneal functions. Nevertheless, growing susceptibility of the cornea to surgical trauma, inflammation, and oxidative stress in old age may be caused by decreased endothelial reserve, especially during intraocular procedures.

Myopia and endothelial changes 3.4.

The principal structural change in myopic eyes is axial elongation, which has been put forward to cause biomechanical stress to anterior and posterior tissues of the eye, corneal endothelium included. This mechanical stretching has the potential of affecting endothelial cell morphology and density, which might contribute to the premature endothelial loss with aging (Hwang et al., 2010).

Nonetheless, the available literature has shown contradictory results on the influence of myopia on the health of endothelial cells. Other studies also note that there is less ECD and higher polymegathism, whereas in the other cases, it appears that there is no alteration of the endothelial parameters regardless of whether they are high or normal myopia (Lee et al., 2015). Such discrepancies can be related to the differences in the study design, the age of the population, the level of myopia and methods of measurements and it is important to note that the issue of such discrepancies can be approached only with further specific studies.

3.5 Reason and the necessity to conduct the study.

Although there is an increased incidence of myopia in India, there is insufficient information comparing corneal endothelial features in myopic patients at various ages. Majority of the reported literature deals with either aging or refractive error alone with less studies touching on their interactive effect on the endothelial health in the context of the Indian population.

The interpretation of age-related endothelial changes in the myopic individuals is of special significance to the surgical planning. Refractive surgery, phakic intraocular lenses implantation, and cataract surgery are surgeries that result in the loss of endothelial cells, and patients who have a low baseline ECD are at risk of developing corneal decompensation after surgery. Thus, endothelial evaluation peculiar to the age in the case of myopic patients is crucial to the achievement of the best results of surgery and reduction of complications.

3.6 Aim and Objectives

Aim

To evaluate corneal endothelial cell density and morphological variations across different age groups in myopic patients.

Objectives

1. **Primary Objective**
   To assess and compare corneal endothelial cell density among myopic patients in different age groups using specular microscopy.
2. **Secondary Objectives**
   - To analyze the relationship between age and endothelial cell density in myopic eyes (Laing et al., 1976).
   - To evaluate age-related changes in average cell area as an indicator of compensatory endothelial remodeling (Rao et al., 1984).
   - To determine the clinical relevance of endothelial alterations in myopic patients for preoperative ophthalmic surgical planning (Bourne, 2003).

4. Materials and Methods

4.1 Study Design and Setting

This study was designed as a **cross-sectional observational study** conducted at a **tertiary eye care center** in South India. The study was carried out over a period of six months after obtaining approval from the Institutional Ethics Committee. All procedures adhered to the tenets of the Declaration of Helsinki, and informed consent was obtained from each participant prior to enrollment.

4.2 Study Population and Sample Size

A total of **50 myopic patients (100 eyes)** aged between **18 and 50 years** were included in the study. Participants were divided into three age-based groups for comparative analysis:

- **Group A:** 18–30 years
- **Group B:** 31–40 years
- **Group C:** 41–50 years

Both eyes of each participant were evaluated to ensure adequate representation of endothelial parameters across the study population.

4.3 Inclusion Criteria

Participants fulfilling the following criteria were included in the study:

- Age between **18 and 50 years**
- Diagnosed myopia with a **spherical equivalent of −0.50 diopters or more**, confirmed by objective and subjective refraction
- Clear cornea with no clinical evidence of endothelial pathology

4.4 Exclusion Criteria

Patients meeting any of the following criteria were excluded:

- History of **ocular surgery or ocular trauma**
- **Contact lens use** within the preceding six months
- Presence of **corneal dystrophies, degenerations, or opacities**
- Active ocular inflammation or infection
- Systemic diseases known to affect corneal endothelium, such as **diabetes mellitus or connective tissue disorders**

4.5 Clinical Evaluation Protocol

All participants underwent a comprehensive ophthalmic evaluation, which included:

- **Best-corrected visual acuity (BCVA)** assessment using Snellen's chart
- **Slit-lamp biomicroscopy** for anterior segment evaluation
- **Intraocular pressure (IOP)** measurement using applanation tonometry
- **Dilated fundus examination** using indirect ophthalmoscopy to rule out posterior segment pathology

Only patients with normal anterior and posterior segment findings were included for endothelial analysis.

4.6 Specular Microscopy Assessment

Corneal endothelial evaluation was performed using **non-contact specular microscopy** (NIDEK CEM-350). Images were captured from the central cornea under standardized lighting conditions. The following endothelial parameters were recorded:

- **Endothelial cell density (ECD)** (cells/mm²)
- **Average cell area (ACA)** (µm²)
- **Cell morphology**, including variation in cell size

Specular microscopy is a reliable and reproducible method for in vivo assessment of corneal endothelial structure and density (Benetz et al., 2013).

4.7 Outcome Measures

- **Primary Outcome Measure:**
  Corneal endothelial cell density (ECD)

across different age groups in myopic patients.

- **Secondary Outcome Measure:** Average cell area (ACA) as an indicator of compensatory endothelial remodeling with age.

4.8 Statistical Analysis

Data were entered into Microsoft Excel and analyzed using **SPSS software (version 25.0)**. Continuous variables were expressed as **mean ± standard deviation (SD)**. Comparison of endothelial parameters across age groups was performed using **one-way analysis of variance (ANOVA)**. The relationship between age and endothelial parameters was assessed using **Pearson's correlation coefficient**. A **p-value < 0.05** was considered statistically significant.

RESULTS: DATA PRESENTATION AND INTERPRETATION

Table 1: Demographic Distribution of Study Participants

Age Group (years)	Number of Patients (n)	Mean Age (years ± SD)
18–30	11	25.7 ± 3.1
31–40	17	35.4 ± 2.7
41–50	22	46.5 ± 3.1
Total	**50**	37.2 ± 7.8

Explanation

The study included 50 myopic patients distributed across three age groups, with the largest proportion belonging to the 41–50 year group. The progressive increase in mean age across groups ensured appropriate stratification for evaluating age-related changes in corneal endothelial parameters. This distribution allowed meaningful comparison of endothelial characteristics across early adulthood to middle age.

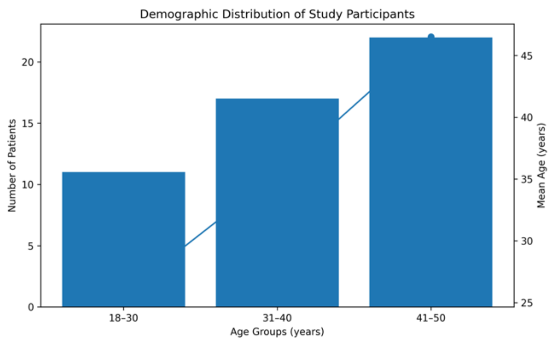


Table 2: Mean Corneal Endothelial Cell Density (ECD) Across Age Groups

Age Group (years)	Right Eye (cells/mm² ± SD)	Left Eye (cells/mm² ± SD)
18–30	2917 ± 164	2925 ± 171
31–40	2802 ± 183	2784 ± 190
41–50	2636 ± 229	2622 ± 237

Explanation

A consistent and progressive decline in corneal endothelial cell density was observed with increasing age in both eyes. Patients aged 18–30 years demonstrated the highest mean ECD, while those in the 41–50 year group exhibited the lowest values. This reduction reflects the physiological age-related loss of endothelial cells and suggests a diminishing endothelial reserve in older myopic individuals. The symmetrical values between right and left eyes indicate uniform endothelial involvement.

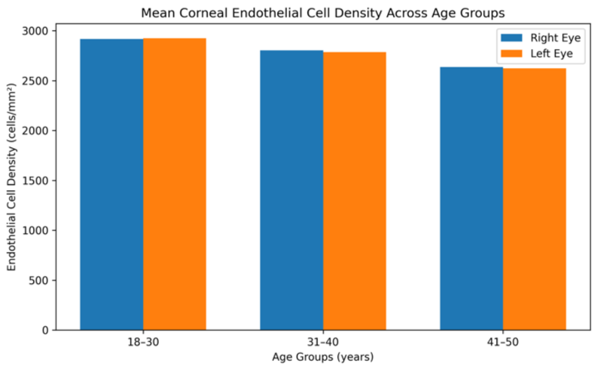
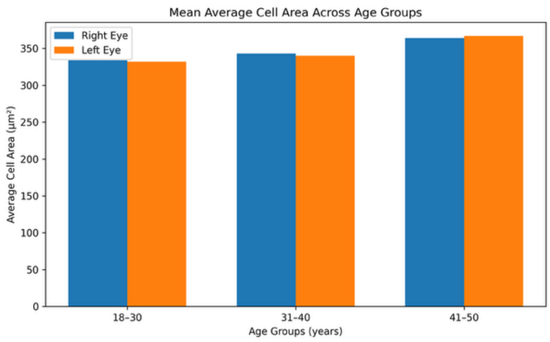


Table 3: Mean Average Cell Area (ACA) Across Age Groups

Age Group (years)	Right Eye (µm² ± SD)	Left Eye (µm² ± SD)
18–30	334 ± 18	332 ± 20
31–40	343 ± 15	340 ± 16
41–50	364 ± 21	367 ± 24

Explanation

An increase in average cell area was noted with advancing age in both eyes. The youngest age group showed the smallest ACA values, while the oldest group demonstrated the largest. This inverse relationship between endothelial cell density and average cell area represents compensatory cellular enlargement (polymegathism) in response to endothelial cell loss, allowing maintenance of corneal endothelial coverage and function.



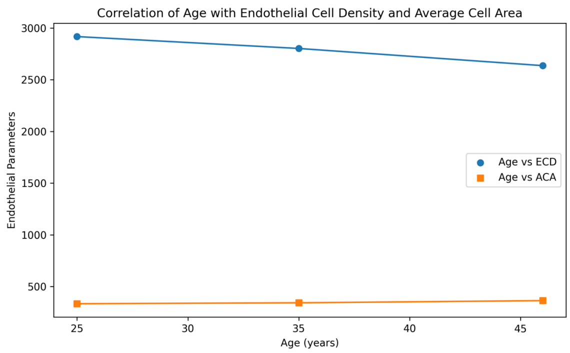
Correlation Analysis

Pearson correlation analysis revealed:

- A **significant negative correlation between age and endothelial cell density** ($r = -0.65$, $p < 0.01$)
- A **significant positive correlation between age and average cell area** ($r = 0.59$, $p < 0.01$)

Explanation

These findings confirm that increasing age is associated with a reduction in endothelial cell density and a corresponding increase in cell size. The statistically significant correlations highlight age as an important determinant of corneal endothelial morphology in myopic patients.



5. Results

5.1 Demographic Characteristics

The participants aged 50 myopic patients (100 eyes) that included 27 males (54 percent) and 23 females (46 percent) with a mean age of 37.2 +- 7.8 years old. The participants were stratified into three age groups namely 18-30 years (Group A), 31-40 years (Group B), and 41-50 years (Group C). Group C was the biggest percentage of the study population. Age distribution was sufficient enough to achieve effective representation of early adulthood to the middle age without undermining the validity of assessing the endothelial responses of the patients with myopia due to age (Table 1).

Age stratification is a widely used method in studies of corneal endothelial to isolate physiological aging effects on the morphology and density of the endothelial cell (Laing et al., 1976).

5.2 Endothelial Cell Density by age.

Mean corneal endothelial cell density (ECD) showed a progressive age related decrease in both eyes (Table 2). The maximum ECD scores were found in Group A (18-30 years), and the minimum ones were found in Group C (41-50 years).

In Group A, the ECD means of right eye and left eye were 2917 +-164 cells/mm2 and 2925 +-171 cells/mm 2 respectively. In Group B these values reduced to 2802 +- 183 cells/mm2 (RE) and 2784 +- 190 cells/mm2 (LE) and in Group C were further reduced to 2636 +- 229 cells/mm2 (RE) and 2622 +- 237 cells/mm2 (LE).

This age regression of ECD is consistent with existing data that the loss of endothelial cells is an irreversible process of continuous loss that progresses functional vulnerability with age (Bourne, 2003).

5.3 Average Cell Area Variation

Meanwhile in contrast to endothelial cell density, average cell area (ACA) did rise with age (Table 3). Group A showed lowest ACA values whereas Group C showed highest ACA values.

Group A had a mean of 334 +- 18 um 2 (RE) in ACA and 332 +-20 um2 (LE). These values rose up to 343 +- 15 um2 (RE) and 340 +- 16 um2 (LE) in Group B and further to 364 +- 21 um2 (RE) and 367 +- 24 um2 (LE) in Group C.

This negative correlation of ECD with ACA is a sign of polymegathism, or compensatory expansion of the few surviving endothelial cells to ensure that the cornea is covered (Rao et al., 1984; Joyce, 2012).

5.4 Correlation Analysis

The Pearson correlation analysis showed statistically significant negative correlation between age and endothelial cell density (r = [?]0.65, p = 0.01) and exposes that ECD declines with age. On the other hand, the average cell area was significantly positively correlated with age ($r = 0.59$, $p < 0.01$) which indicates that cellular enlargement occurred with increasing age. These results are consistent with previous studies which found that the aging process results into depletion of endothelial reserve with compensatory morphological remodeling when there is no evident corneal pathology (Laing et al., 1976; Bourne, 2003).

5.5 Key Statistical Findings

One way analysis of variance (ANOVA) comparison of endothelial parameters among the three age groups revealed that there is a statistically significant difference in mean endothelial cell density in all three age groups ($p < 0.05$). The step-by-step reduction in ECD with age groups, as it was observed in post-hoc interpretation proved age to be an important predictor of endothelial well-being.

The correlation coefficients of Pearson also determined the strength and direction of relationships between age and endothelial parameters. The negative correlation coefficients between the age and ECD (moderate and strong) as well as the positive correlation coefficients between the age and the ACA indicate the interaction between aging and myopia in corneal endothelial morphology (Rao et al., 1984; Joyce, 2012).

6. Discussion

6.1 Summary of Key Findings

This current research shows that there is a progressive statistically significant reduction in the density of corneal endothelial cells (ECD) as age advances among myopic patients between ages 18-50 years. The peak ECD values were found in younger adults (18-30 years old), and the lowest one was found in the 4150 years age group. Parallel to this, there was an increase in the compensatory enlargement of endothelial cells along the form of average cell area (ACA).

These results imply that even though endothelial cell loss is subject to a pattern of physiological aging, myopic eyes might have lesser endothelial reserve with age, which might put a person at risk of surgical stress and endothelial decompensation.

6.2 Comparison to the prior literature.

The endothelial cell density decreases with age in this study just like the classical and modern literature. The initial report of progressive and irreversible depletion of corneal endothelial cells with old age was made by Laing et al. (1976) in normal eyes. Equally, Bourne (2003) noted that the endothelial cell density drops progressively as life progresses, and that functional effects that are clinically significant when the endothelial reserve is impaired.

There have been conflicting studies comparing myopia- specific endothelia change. Hwang et al. (2010) found that the ECD and the cell size variation were lower in highly myopic eyes which was due to axial elongation and biomechanical stress. However, Lee et al. (2015) implied that endothelial parameters might be in the normal range in low to moderate myopia, with the degree of myopia and age distribution affecting the results of the study.

The results of the current research are consistent with the literature that demonstrated that age is a prevailing factor to the loss of endothelial cells, and myopia can modify but not cause endothelial injury.

Pathophysiological Explanations.--Here, dysfunction is thought to cause illness and disease due to a primary process known as pathogenesis, in which diseases represent abnormal cellular functions that trigger the task force of illness and progression into disease.<|human|>Pathophysiological Explanations.--Here, illness and disease are believed to occur on the basis of a central process living pathogenesis, where diseases are abnormal cellular functions that stipulate the arm of labour of illness and their transformation into disease.

The endothelial changes observed in myopic patients can be attributed to a number of mechanisms. Elongement of the axes, one of the characteristics of myopia, is thought to cause biomechanical tension on ocular tissues, which may cause corneal curvature and endothelial integrity (Hwang et al., 2010). Stabilization of the endothelial cells by chronic stretching forces can reduce the cell stability and enhance age-associated attrition.

Further, remodeling and endothelial stress are compensatory measures to cell loss. Due to the lack of regenerative capacity of corneal endothelial cells, surviving endothelial cells grow and repopulate corneal deturgescence, leading to higher average cell area and polymegathism (Joyce, 2012). This adaptation mechanism can eventually be inadequate especially in the elderly or patients who have undergone surgical trauma.

6.4 Clinical Implications

Reduced endothelial reserve in aging myopic patients has clinical implications. Endothelial stress may occur directly or indirectly due to the process of refractive surgical procedures, such as LASIK and phakic intraocular lens implantation. It is also important to conduct preoperative endothelial assessment in order to detect patients at risk of developing postoperative complications (Bourne, 2003).

Likewise, surgery on the cataract, particularly in the eyes that are myopic and those that have more profound anterior chambers and altered eye anatomy, can lead to increased endothelial cell loss. Patients with borderline preoperative ECD have the risk of accelerating postoperative corneal edema and slow rates of visual recovery. Regular specular microscopy in patients with a myopic vision (especially aged above 40 years) may assist in surgery planning and risk assessment (Rao et al., 1984).

6.5 Strengths of the Study

The main advantage of this work is that objective and non-contact specular microscopy was used, which offers reliable and reproducible values of endothelial parameters. Also, the systematic assessment of age-related endothelial changes in a specified population with a myopic focus was enabled by the notable age stratification, increasing the clinical significance of the findings.

6.6 Limitations

The study, as far as it is good, has some limitations. The small size of the sample can also be a limitation in terms of generalization. The cross sectional design limits the capability of measuring longitudinal endothelial cell loss across time. In addition, the lack of data on axial length and corneal pachymetry inhibits the possibility of a direct correlation of biomechanical factors with endothelial changes.

6.7 Future Research Directions

The next research must be conducted on a longitudinal basis to determine the extent of endothelial cell loss in myopic patients depending on their age groups. Adding the severity-based stratification of myopia (low, moderate, and high) would aid in the clarification of the independent effect of the extent of refractive errors on the endothelium (Hwang et al., 2010). Addition of biometric measurements like axial length and corneal thickness can also increase knowledge on the structural processes of endothelial health.

7. Conclusion

The current research indicates that corneal endothelial cell density (ECD) reduces significantly with age in patients with myopia with the age range of 18-50 years. The young people showed more counts of endothelial cells and there was a progressive decrease in ECD that took place with higher age with corresponding compensatory increase in endothelial cell size. These results suggest gradual decrease in endothelial reserve with the increase in age in myopic eye.

The findings demonstrate clinical relevance of regular corneal endothelial assessment especially in myopic individuals at the age of 40 years and above who can have reduced endothelial resistance. Early detection of the reduced ECD may help clinicians to assess the risk in surgeries and determine the suitable methods to use. Clinically, endothelial health preoperative examination plays a very significant role in preventing postoperative corneal decompensation particularly in patients who are undergoing refractive procedures, cataract surgery, or phakic intraocular lens implantation. The insertion of the specular microscopy as part of the standard pre-surgical assessment plan will enhance patient safety as well as maximize the visual outcomes in the increasing myopic population

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