Research Article

Corneal Endothelium and Central Corneal Thickness Changes in Patients with Primary Open Angle Glaucoma

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Abstract

Purpose: The purpose of this study was to compare corneal endothelial morphometric changes and central corneal thickness (CCT) in patients with primary open-angle glaucoma (POAG) with age-matched, non-glaucomatous control subjects using CEM-530 NIDEK indirect specular microscope. In addition, the associations between endothelial changes and IOP; glaucoma duration and topical anti-glaucoma medications were performed.

Methods: The study included 44 patients (44 eyes) with POAG and 50 control (non-glaucomatous) subjects (50 eyes). Corneal endothelial changes and CCT were measured for all patients using CEM-530 NIDEK indirect specular microscope.

Results: This study demonstrated a high statistically significant difference in endothelial cell density (ECD), average cell area, maximum cell area and standard deviation of cell area between the 2 groups (P=0.000). However, the study showed no statistically significant differences in coefficient of variation (CV), hexagonality and CCT between the 2 groups. Pearson correlation analysis showed that POAG group had a statistically weak positive correlation between IOP and maximum cell area (r=0.323 & P=0.033) and hexagonality (r=0.313 & P=0.038). Moreover, POAG group had a statistically weak negative correlation between age and CCT (r= -0.303 & P=0.046).

Conclusion: This study documented lower ECD and larger average endothelial cell area in POAG patients. Therefore, it is mandatory to use all precautions to protect the corneal endothelial cells from further impairment during any anterior segment operations. In addition, the study confirmed a positive correlation between IOP and maximum cell area in glaucomatous eyes. On the other hand, endothelial parameters and CCT showed no significant correlations with the number of medications and duration of glaucoma. Therefore, further studies using a longitudinal large population-based prospective design are recommended to verify the extent of endothelial damage caused by POAG and to determine factors prognostic of enhanced endothelial damage.

Keywords: primary open-angle glaucoma, endothelial cell density, central corneal thickness, non-contact specular microscopy.

Intruduction

Glaucoma is a group of ocular disorders manifested by a specific pattern of optic nerve neuropathy, and visual field defects that are related significantly but not in all cases with an elevated intraocular pressure (IOP) [1, 2]. Helayel

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Amira Elagamy, Assistant Professor of Ophthalmology, Department of Optometry and Vision Sciences, College of Applied Medical Sciences, King Saud University, Saudi Arabia and Mansoura Ophthalmic Center, Faculty of Medicine, Mansoura University, Egypt
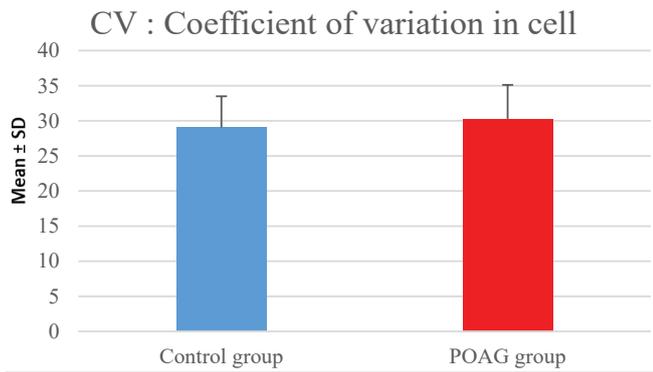
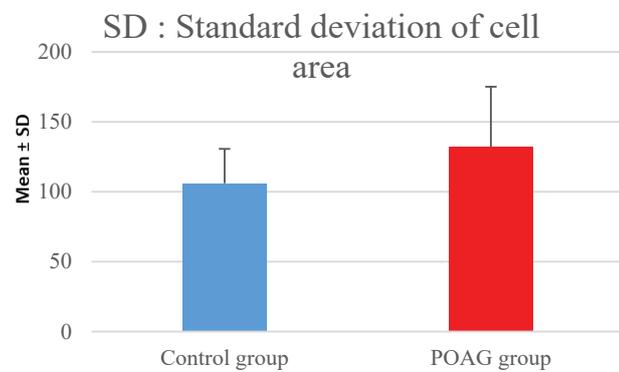**Figure 1:** The comparison of CV (%) between the two groups.

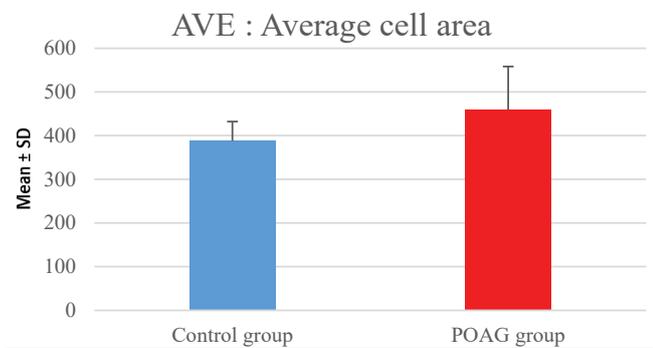**Figure 2:** The comparison of SD (μm2) between the two groups.

Figure 3: The comparison of average sell area (μm2) between the two groups.

and visual acuity in all glaucoma patients. This study evaluated corneal endothelial changes and CCT in patients with POAG compared to control patients. The study found no statistically significant difference in IOP between the two groups (P=0.070) because all POAG patients enrolled in the study were on glaucoma medications. POAG group showed mean of IOP 16.36± 4.51 (10.00-30.00 mmHg) compared to 14.36±3.39 (10.00-20.00 mmHg) in the control group.

In this study, POAG group showed a significantly lower ECD and a larger average cell area compared to the control

group. This finding matched with Zarnowski et al [6] Cho et al [7] and Yu et al [10] Cho et al [7] investigated POAG patients who did not receive antiglaucoma medication. Yu et al [10] demonstrated that POAG eyes had significantly lower ECD compared to the healthy control eyes (P < 0.001) and the treated eyes had significantly lower ECD compared to the untreated eyes. Also, Bhomaj et al8 documented a significant reduction in endothelial cell count in POAG patients compared to normal eyes (185 cells/mm2) (95% CI = 132–238 cells lower, P < 0.001). In their study, timolol monotherapy was the most common anti-glaucoma treatment being used by POAG patients (n = 30 %), followed by latanoprost (n = 14%) and combination of latanoprost and timolol (n = 14 %). A few patients were using brimonidine either alone (n = 12%) or in combination with timolol (n = 8%). Minority patients were using a combination of dorzolamide with timolol (n = 9%). In addition, Swamy and Tasneem 2020 [14] found a significant difference in ECD between the newly detected POAG patients and controls (P<0.001). Additionally, Knorr et al5 showed a 31% decrease in corneal ECD in POAG patients compared with the healthy subjects. Similarly, Cho et al [7] and Gagnon et al [11] confirmed a 13.0% reduction in ECD in POAG patients compared to control eyes. Gagnon et al [11] examined glaucoma patients who had used glaucoma medication. Tham et al 2006 [15] explained the significant
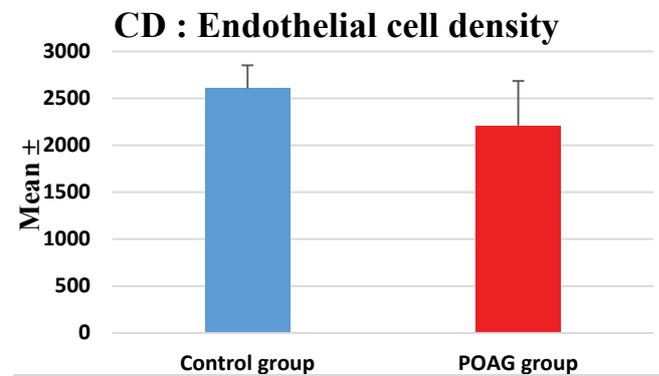

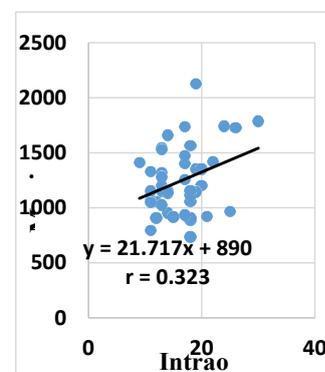**Figure 4**: The comparison of endothelial cell density (cell/mm2) between the two groups.

Figure 5: Correlation between intraocular pressure and maximum cell area.

increase of average cell area in glaucomatous eyes by the renewing incapacity of corneal endothelium. The corneal endothelial cells have to expand to maintain corneal clarity. However, Lee et al [9] and Korey et al [16] demonstrated no reduction in ECD in POAG eyes. Korey et al [16] assumed that the corneal endothelium has the capability to adapt to a gradual and modest increase in IOP, even if it continues for a prolonged period, without displaying significant changes. Conversely, Inatani et al [17] suggested that a slight increase in IOP over an extended period can lead to glaucoma progression, and it may also induce a reduction in ECD. On the other hand, the length of the duration which is required by the minor elevation of IOP to cause a significant decrease in ECD is still unknown. Consequently, longitudinal studies may be necessary to approve this hypothesis.

This study demonstrated no significant differences between the 2 groups regarding CV and hexagonality. This result agreed with Cho et al [7]. However, Bhomaj et al [8] confirmed significantly higher CV values. They reported significant pleomorphism and polymegathism in eyes with POAG (P < 0.001). Swamy and Tasneem 2020 [14] found a significant difference between hexagonality and CV between the newly detected POAG patients and controls (P=0.001, P=0.002 respectively). However, many studies [18-20] confirmed that the alterations in CV and Hexagonality are only induced by an acute corneal endothelial damage. The current study documented no significant differences between the 2 groups regarding CCT which matched with Lee et al.9 Also, Wu et al [21] documented no significant difference in CCT among NTG, POAG, and normal subjects but a higher CCT in OHT subjects. Conversely, Swamy and Tasneem 2020 [14] found a significant difference in CCT between the newly detected POAG patients and controls (P=0.027).

This study investigated the association between corneal endothelial changes and IOP, glaucoma duration and medications. The study reported a positive correlation between mean IOP and maximum cell area in POAG group (r=0.323 & P=0.033) which agreed with Yu et al10 who showed a positive correlation between maximum cell area and mean IOP (r = 0.218, P = 0.029). Moreover, they found a positive correlation between the average cell area and mean IOP (r = 0.228, P = 0.022) and minimum cell area and mean IOP (r = 0.290, P = 0.003). However, they documented a negative correlation between cell density and mean IOP (r = −0.286, P = 0.004). On the other hand, they did not report any association between the mean IOP and the percentage of hexagonal cells.

Swamy and Tasneem 2020 [14] investigated the association between ECD and mean IOP in the newly detected POAG patients and controls and found that the patients with 10-15mm Hg have ECD of 2500-3000 cells/mm2 compared to ECD of 2000-2500 cells/ mm2 (39%) with an increasing

IOP beyond of 20-25mm Hg. Pearson correlation analysis in this study showed that endothelial parameters and CCT had no significant correlations with the number of medications and duration of glaucoma in POAG group. On the other hand, POAG group had a statistically weak negative correlation between age and CCT. This result agreed with Galgauskas et al [22] who reported a statistically significant negative correlation was found between CCT and age (r=-0.263, P<0.05). However, Natarajan et al23 found no statistical difference in CCT among various ages.

This study had some limitations. First, the study did not include a group of newly diagnosed POAG patients to exclude the effect of glaucoma medication on the corneal endothelium. Second, pre medication records of the endothelial morphometric parameters of POAG group were not available to evaluate accurately the extent of damage after the medication. The unavailability of these records made us unable to determine whether the reason for decreased ECD was the amount of elevated IOP or other factors such as congenital problems. Third, evaluation of the correlation between the endothelial morphometric parameters and Cup-Disc Ratio was not performed in this study. Fourth limitation is the lack of longitudinal data to show rate of progressive loss of ECD.

Conclusion

This study documented lower ECD and larger average endothelial cell area in POAG patients. Therefore, it is mandatory to use all precautions to protect the corneal endothelial cells from further impairment during any anterior segment operations. In addition, the study confirmed a positive correlation between IOP and maximum cell area in glaucomatous eyes. On the other hand, endothelial parameters and CCT showed no significant correlations with the number of medications and duration of glaucoma. Therefore, further studies using a longitudinal large population-based prospective design are recommended to verify the extent of endothelial damage caused by POAG and to determine factors prognostic of enhanced endothelial damage.

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