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Original Article

A STUDY oF CORNEAL ENDOTHELIAL SPECULAR MICROSCOPY IN MIDDLE AGED PATIENTs WITH CATARACT

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Abstract

Purpose: *To study the corneal endothelium by specular microscopy in middle aged patients with cataract.* ***Methods:*** *this is observational cross-sectional retrospective clinical study. It included 500 eyes of 500 patents (244 females and 256 males) with cataract whose ages were between 40 and 60 (mean, 51.99 ± 7.32) that accepted to participate in this study in Sohag ophthalmic investigation center from the period of September 2017 to November 2018. Non-contact Topcon specular microscopy (model SP-1S, Japan) was performed in the studied eyes. Endothelial cell density (ECD), coefficient of variation (CV) in cell size, hexagonality of cells (HEX), and number of cells (N) were measured.* ***Results*****:** *ECD readings ranges from 2017-3931 with a mean of 2835.29 and SD of 476.01. The median of COV is 36 and the range lies between 23-91. The mean of HEX is 50.61 with SD of 9.85 while the median is 52. Number of corneal cells in the study group ranges from 97-457 cells with a mean of 158.39 cells and SD of 55.86, while the median is 145 cells. The results of the present study revealed that the mean of endothelial cell density is 2835.29 ± 476.01 cell/mm2, coefficient of variation in cell size is 37.78 ± 9.60 %, hexagonality of cells is 50.16 ± 9.85 % and number of cell is 158.39 ± 55. 86 cells.* ***Conclusion:*** *Specular microscopy can provide a non invasive morphologic analysis of the corneal endothelial cell layer from subjects enrolled in clinical trials.*

Keywords: *Corneal endothelium, Specular microscopy, Cataract*

1. Introduction

The normal cornea is lined on its inner surface by one layer of endothelial cells [1], the cell density of which is usually reported as the number of cells/mm^2. This endothelial cell density (ECD)assessment may be undertaken directly by counting the cells within a determined area of the corneal endothelium [2] or by indirect way by measuring the areas of the cells and then making a calculation of the estimated cell density [3,4]. Allowing for some age-related reductions in ECD, the status of the endothelium in terms of its density is widely accepted as an indicator of corneal health and freedom from disease, acquired inflammation or iatrogenic damage [5-6]. ECD is the most widely reported measure of the corneal endothelium and quite often the only measure. Any assessment of ECD,

whether based on counts or area measures, does not provide any indication of the possible variability in the cells, either in terms of their size (area) or shape (for example, the 'hexagonality' or percentage of six-sided cells) [3]. With the advent of numerous different image analysis software options on specular or confocal microscopes, it has become easier to try to assess this variability by reporting on the polymegethism (variability in cell areas) and/or the polygonality (variability in the number of cell sides). It is the polymegethism that has received the most attention, with an index of polymegethism being reported as the coefficient of variation (COV) on the measured cell areas, usually reported as a percentage. Polymegethism can also be graded with the support of sets of representative images [7] or schematics [8]. Specular microscopy is used to view and record non-invasively the image of the corneal endothelial cell layer [9,10]. The clinical specular microscopic devices are all based on the original laboratory microscope designed by Maurice to allow a high magnification view of specular reflected light from the corneal endothelium. The specular reflex occurs at a regular, smooth surfaced interface of two refractive indices with the light from the subject having an angle of incidence equal to the angle of reflection to the observer. The endothelial cells can be imaged because the refractive index of the endothelial cells is greater than the 1.336 value for aqueous humor, thus reflecting 0.022% of the projected light [11]. Early reports from 1920 describe the use of specular reflex light with the slit lamp to view the corneal endothelium [12].

2. Patients and Methods

Type of the study: observational cross-sectional retrospective clinical study done in the period from September 2017 to November 2018.

2.1. *Patients*

We evaluated a 500 eyes of 500 patents (244 females and 256 males) with cataract whose ages were between 40 and 60 (mean, 51.99 ± 7.32) that accepted to participate in this study voluntarily after they were informed about the procedures within the scope of the study in Sohag ophthalmic investigation center.

2.1.1. Inclusion criteria

Age ranges from 40 to 60 years, Confirmed cataract, clear cornea.

2.1.2. Exclusion criteria

We excluded any ocular disease other than cataract as: Corneal opacity, glaucoma, keratoconus, retinal disease, evidence of endothelial dystrophy. Previous ophthalmic herpes infection, past history of uveitis. Diabetes mellitus, Pregnancy. Collagen vascular diseases, Severe dry eye. We also excluded contact lens wear, systemic treatment, and any history of previous ocular surgery.

2.2. *Methods*

The procedure was explained to patients eligible for inclusion and the consent form was signed. Before the operation; all patients were subjected to:
1) A detailed ocular and medical history.
2) Complete ophthalmic exam-ination which included:

a. Slit lamp examination to exclude corneal opacity or inflammation.

b. Fundus examination to detect any posterior segment abnormalities.

3) Non-contact Topcon specular microscopy (model SP-1S, Japan), fig. (1), was performed in the studied eyes. Endothelial cell density (ECD), coefficient of variation (CV) in cell size, hexagonality of cells (HEX), and number of cells (N) were measured. The

shape of the endothelium is obtained on an incorporated screen. After a clear image of the central endothelium was captured, the computer performed an automated analysis of the cell parameters that were displayed on the screen and then a printout was obtained as shown in fig. (2). Data analysis was performed using SPSS software (version 16.0, SPSS, Inc.). Shapiro-Wilk test was used to test normality of distribution of the data, the test was significant indicating that the data are non-parametric and don't follow the normal distribution.

2.3. *Statistical analysis*

Mann-whitney U test was used to detect the differences in the outcome variables between males and females. Spearman Correlation was used to examine the change in endothelial cell characteristics with age. Data are shown as mean ± standard deviation (SD). p values less than 0.05 were considered significant.

Figure (1) Shows SP-1S Topcon specular microscopy

Figure (2) Shows an automated analysis of the cell parameters of normal specular microscopy.

3. RESULTS

Samples of five hundred middle aged population with cataract were evaluated. Their ages ranges from 40-60 years (mean, 51.99 ± 7.32) as shown in fig (2). The study group consists of 244 female and 256 males. Table (1) shows that ECD readings ranges from 2017-3931 with a mean of 2835.29 and SD of 476.01. The median of COV is 36 and the range lies between 23-91. The mean of HEX is 50.61 with SD of 9.85 while the median is 52. Number of corneal cells in the study group ranges from 97-457 cells with a mean of 158.39 cells

and SD of 55.86, while the median is 145 cells. There is significant (P <0.05) negative correlation between age and ECD which means that ECD decreases as the age increases. There is also significant negative correlation between age and number of corneal cells. The correlations between age and the other two outcomes (COV and HEX) are statistically insignificant, tab. (2). Table (3) shows that the mean of CD among the studied females is fairly above 2790 with SD fairly above 460, while the mean among males is near to 2877 with SD of 487.24 with statistically significant difference between them. There is also significant difference between males and females in COV (mean ± SD, 38.57 ± 9.99 and 36.94 ± 9.13 respectively). The number of corneal cells also varies significantly between both males and females (mean ± SD, 167.42 ± 64.83 and 148.91 ± 42.67 respectively). However, there is no significant difference between females and males regarding HEX. We evaluated a 500 eyes of 500 patients (244 females and 256 males) with cataract whose ages were between 40 and 60 (mean, 51.99 ± 7.32) that accepted to participate in our study voluntarily after they were informed about the procedures within the scope of the study in Sohag ophthalmic investigation center. Non-contact SP-1P Topcon specular microscopy was performed in the studied eyes with cataract. Endothelial cell density (ECD), coefficient of variation (CV) in cell size, hexagonality of cells (HEX), and number of cells (N) were measured. The results of the present study revealed that the mean off endothelial cell density is 2835.29 ± 476.01 cell/mm^2, coefficient of variation in cell size is 37.78 ± 9.60 %, hexagonality of cells is 50.16 ± 9.85 % and number of cell is 158.39 ± 55. 86 cells

Table (1) Corneal endothelial cell characteristics of the studied population, Sohag, 2018.

	Min-Max	Mean ± SD	Median
ECD	2017-3931	2835.29 ± 476.01	2796
COV	23-91	37.78 ± 9.60	36
HEX	21-77	50.16 ± 9.85	52
Number of cells	97-457	158.39 ± 55. 86	145

Table (2) Correlation between outcome variables and age among the studied population, Sohag, 2018.

	ECD	COV	HEX	Number of cells
Age r	-0.63	0.01	-0.08	-0.33
P value	0.00*	0.82	0.09	0.00*

Table (3) Outcome variables among the studied males and females, Sohag, 2018.

	Female		Male		P value
	Median	Mean ± SD	Median	Mean ± SD	
ECD	2747	2790.83 ± 460.75	2894.50	2877.67 ± 487.24	0.05*
COV	35	36.94 ± 9.13	36	38.57 ± 9.99	0.01*
HEX	52	50.65 ± 9.22	52	49.68 ± 10.42	0.66
Number of cells	142	148.91 ± 42.67	147	167.42 ± 64.83	0.00*

4. DISCUSSION

Many studies showed that corneal endothelial cell density alterations with aging. These studies report that ECD, percentage of hexagonal cells, and number of cells decrease with age [13-17]. In our study on 500 eyes in Sohag in middle aged patient with cataract with a non-contact specular microscopy (SP2000: Topcon corporation, Japan) we found that CD readings ranges from 2017-3931 with a mean of 2835.29 ± 476.01 cells/ mm^2. There was significant negative correlation (P < 0.05) between age and ECD which means that ECD decreases as the age increases. There is also significant negative correlation between age

and number of corneal cells. The correlations between age and the other two outcomes (COV and HEX) are statistically insignificant. Hoffer and Kraff [18] reported their analysis of routine preoperative cell counts on 2000 eyes with cataract in the 40- to 90-year age range. Their study showed that the average mean endothelial cell count is 2400 cells/mm^2 for individuals 40 to 90 years of age, whereas the range of individual cell counts for these corneas is 1500 to 3500 cells/mm^2. Estimation of the endothelial reserve is made by comparing a cornea's endothelial cell count to the normal range of 1500 to 3500 cells/mm2 (age, 40-90). If the cell count is in the upper range, the cornea may be able to withstand more surgical trauma because it retains a sufficient density of endothelial cells even after greater endothelial cell loss. Conversely, if the cell count is in the lower range, the cornea may be unable to sustain as much damage, may take longer to heal, and may have a greater chance of decompensate and requiring a corneal transplant. Ourstudy results strongly correlate with the normal range of Hoffer and Kraff analysis of endothelial cell count in spite of conducting the study on middle aged patients (40-60 years) only. Hashemian et al. [19] reported a mean endothelial cell density of 1961 ± 457 cell/mm^2 among 525 eyes of normal Iranian people aged 20-85 years old with a non contact specular microscopy (SP2000: Topcon corporation, Japan) relativelly correlate with our study in spite of little differance in age group of selected patients. Yunliang et al. [16] performed specular microscopy in 1329 eyes of 700 healthy Chinese people aged 10–98 years and evaluated the mean endothelial cell density of their population as 2932 ± 363 cell/mm^2 with (Non con Robo SP-9000; Konan, Hyogo, Japan) that also correlate with our study. Ceyhun et al. [20]. reported a mean endothelial cell density of 2671 ± 356 cell/mm^2 among 252 eyes of normal Turkish people aged 20-70 with non contact specular microscopy (SP-3000P: Topcon corporation, Tokyo, Japan), these study also supports our results. Regarding the effect of sex on corneal endothelial cell densities and morphology and central corneal thickness, some studies showed statistically significant differences of corneal endothelial cell densities between genders [15,21], but others did not find statistically significant differences of corneal endothelial cell densities between genders [14,19,22]. Previous studies reported that males have thicker central corneas than females [23,24] other studies did not find such a difference [25,26]. The results revealed that significant differences were not noted in corneal endothelial cell density and morphology and central corneal thickness between males and females within ethnic groups and that strongly support our study.

5. Conclusion

Specular microscopy can provide a non invasive morphologic analysis of the corneal endothelial cell layer from subjects enrolled in clinical trials.

References

1. Doughty, M. Comparative anatomy and physiology of the cornea and conjunctiva. In: Martin Herranz, R., Corrales, R (eds). ***Ocular Surface. Boca Raton***, CRC Press, Florida, USA, 2012: 32-78.
2. Jonuscheit, S., Doughty, M., Ramaesh, K. Assessment of a variable frame (polygonal) method to estimate corneal endothelial cell counts after corneal transplantation. **Eye**. 2012; 26: 803-809.

3. Doughty, M. Towards a quantitative analysis of corneal endothelial cell morphology—a review of techniques and their application. ***Optom Vis Sci1***. 989; 66: 626-642.

4. Doughty, M., Müller, A., Zaman, M. Assessment of the reliability of human corneal endothelial cell density estimates using a non contact specular microscope. ***Cornea***. 2000; 19: 148-158.

5. Waring, G., Bourne, W., Edelhauser, H., Kenyon, K. The corneal endothelium: Normal and pathological structure and function. ***Ophthalmology***. 1982; 89: 531-590.

6. McCarey, B., Edelhauser, H., Lynn, M. Review of corneal endothelial specular microscopy for FDA clinical trials of refractive procedures, surgical devices, and new intraocular drugs and solutions. ***Cornea***. 2008; 27: 1-16.

7. Terry, R., Schnider, C., Holden, B., Cornish, R., Grant, T., Sweeney, D., La Hood, D., et al. CCLRU standards for success of daily and extended wear contact lenses. ***Optom Vis Sci1***. 993; 70: 234-243.

8. Yee, R., Matsuda, M., Edelhauser, H. Wide-field endothelial counting panels. ***Am J Ophthalmol***. 1985; 99: 596-597.

9. Maurice, D. Cellular membrane activity in the corneal endothelium of the intact eye. ***Experientia***. 1968; 24: 1094-1095.

10. Laing, R., Sandstrom, M., Leibowitz, H. In vivo photomicrography of the corneal endothelium. ***Archives of Ophthalmology***. 1975; 93: 143-145.

11. Laing, R., Sandstrom, M., Leibowitz, H. Clinical specular microscopy. I. Optical principles. ***Archives of Ophthalmology***. 1979; 97: 1714-1719.

12. Volt, A. I do not know. ***Graefes Archives Kin Ophthalmology***. 1920; 101: 123.

13. Joyce Nancy, C. Proliferative capacity of corneal endothelial cells. ***Exp Eye Res***. 2012; 95 (1): 16-23.

14. Rao, S., Ranjan Sen, P., Fogla, R., Gangadraharan, S., Padmanabhan, P., Badrinath, S. Corneal endothelial cell density and morphology in normal Indian eyes. ***Cornea***. 2000; 19: 820-823.

15. Padilla, M., Sibayan, S., Gonzales, C. Corneal endothelial cell density and morphology in normal Filipino eyes. ***Cornea***. 2004; 23: 129-135.

16. Yunliang, S., Yuqiang, H., Ying-Peng, L., Ming-shi, Z., Lam, D., Rao, S. Corneal endothelial cell density and morphology in healthy Chinese eyes. ***Cornea***. 2007; 26: 130-132.

17. Galgauskas, S., Krasauskaite, D., Pajaujis, M., Juodkaite, G., Asoklis, R. Central corneal thickness and corneal endothelial characteristics in healthy, cataract, and glaucoma patients. ***Clin Ophthalmol***. 2012; 6: 1195-1199.

18. Hoffer, K., Kraff, M. Normal endothelial cell count range. ***Ophthalmology*** 1980; 87: 861-865.

19. Hashemian, M., Moghimi, S., Fard, M., Fallah, M., Mansouri, M. Corneal endothelial cell density and morphology in normal Iranian eyes. ***BMC Ophthalmol***. 2006; 6 (1): 9

20. Ceyhun, A., Arslan, O., Dikkaya, F. Corneal endothelial cell density and morphology in healthy Turkish eyes. ***J. Ophthalmol***. 2014; 2014, 1-5

21. Snellingen, T., Rao, G., Shrestha, J., Huq, F., Cheng, H. Quantitative and morphological characteristics of the human corneal endothelium in relation to age, gender, and ethnicity in cataract populations of South Asia. ***Cornea***. 2001; 20 (1): 55-58.

22. Mohammad-Salih, P. Corneal endothelial cell density and morphology in normal Malay eyes. ***Med J Malaysia***. 2011; 66 (4): 300-303.

23. Hwang, Y., Kim, H., Sohn, Y., Namil study group, Korean Glaucoma Society central corneal thickness in a Korean population: the Namil Study. ***Invest Ophthalmol Vis Sci***. 2012; 53 (11): 6851-6855.

24. Nangia, V., Jonas, J., Sinha, A., Matin, A., Kulkarni, M. Central corneal thickness and its association with ocular and general parameters in Indians: the Central India Eye and Medical Study. ***Ophthalmology***. 2010; 117 (4): 705-710.

25. Day, A., Machin, D., Aung, T., Gazzard, G., Husain, R., Chew, P., Khaw, P., Seah, S., Foster, P. Central corneal thickness and glaucoma in East Asian people. ***Invest Ophthalmol Vis Sci***. 2011; 52 (11): 8407-8412.

26. Wang, D., Huang, W., Li, Y., Zheng, Y., Foster, P., Congdon, N., He, M. Intraocular pressure, central corneal thickness, and glaucoma in Chinese adults: the Liwan Eye Study. ***Am J Ophthalmol***. 2011; 152 (3): 454-462.