ORIGINAL ARTICLE

The Effect of Phacoemulsification on Corneal Endothelial Cells Morphology and Thickness

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ABSTRACT

Purpose: To compare the corneal endothelial cells morphology and central corneal thickness (CCT) before and after phacoemulsification in Sudanese population.

Place and Duration of Study: Al-Neelain eye hospital, Khartoum, Sudan, from January 2018 to May 2018.

Study Design: Observational longitudinal study.

Methods: One hundred and forty eyes of 140 patients with immature senile cataract were selected by convenient sampling. The age ranged from 40 to 85 years. The patients underwent complete ocular examination including morphology of corneal endothelial cells and CCT using computerized non-contact specular microscope. Inclusion criteria for the study was eyes with normal corneal endothelial cells and cell density more than 1000 cells/mm^2. We excluded patients with ocular or systemic diseases, previous history of intraocular surgery, refractive surgery or trauma as well as contact lenses wear. The patients underwent phacoemulsification by a single surgeon. The examination parameters were repeated one month after surgery. Descriptive and comparative statistical analyses were performed using SPSS for Windows Version 21.0.

Results: There was significant reduction in mean endothelial cells density after phacoemulsification compared to baseline with $p < 0.001$. There was also significant post-operative reduction in mean endothelial cells number as compared to baseline (P value < 0.001). Mean endothelial cells hexagonality was reduced after surgery with P value of 0.003. No significant difference was found between mean coefficient variation of endothelial cells size before and after phacoemulsification (P = 0.55). Central corneal thickness showed significant increase post-operatively, P = 0.003.

Conclusion: Phacoemulsification causes significant damage to corneal endothelium cells, including decrease in corneal endothelial cell density, hexagonality and cell number.

Key Words: Corneal endothelium, Endothelial cell density, Central corneal thickness, Phacoemulsification.

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INTRODUCTION

Visual impairment and blindness are major public health problems in developing countries where there is limited health-care service. Senile cataract is a leading cause of visual impairment among different

communities. The crystalline lens loses its natural transparency resulting in misty vision and eventually gradual loss of vision. Age-related cataract is commonest type of acquired cataract affecting persons above 50 years and responsible for over 47% of blindness globally.[1] Phacoemulsification is one of the choices of surgical treatment of cataract. It affects the corneal structure, which may change the corneal endothelium that has important role in keeping cornea transparent. A significant change in endothelial cells, corneal thickness and corneal endothelial cell density occurs during cataract surgery, resulting in prolonged corneal oedema. Some patients with senile cataract come with corneal oedema after phacoemulsification surgery which may develop to corneal opacity that result in irreversible visual impairment. Several studies clearly showed that there is reduction in corneal endothelial cell count as well as increased central corneal thickness after phacoemulsification.[2]

Since no study was conducted in Sudan to assess the corneal morphological changes after phacoemulsification, we carried out this research to evaluate corneal endothelium morphological and central thickness changes pre-operatively and post-operatively among Sudanese patients. The results represent a crucial role towards understanding how phacoemulsification surgery may affect habitual corneal endothelial cells morphology and central corneal thickness among Sudanese.

METHODS

This longitudinal observational study evaluated 140 Sudanese patients who underwent phacoemulsification surgery in one eye during from January 2018 to May 2018 at Al-Neelain University eye hospital, Sudan. Inclusion criteria for the study was eyes with normal corneal endothelial cells and cell density more than 1000 cells/mm^2. Eyes with anterior chamber depth of more than 2.5mm and normal IOP (10–22 mmHg) were included. The study excluded any patients with ocular or systemic diseases, history of previous intraocular surgery, refractive surgery or trauma as well as contact lenses wear. Ethical approval for study was obtained from Al-Neelain University and was conducted according to the Declaration of Helsinki guidelines.

A comprehensive eye examination was performed including detailed history, refraction using Topcon autorefractometer and best corrected visual acuity (BCVA, decimal notation).Slit lamp examination and fundus examination were carried out and B-scan was used when retina was not visible. Corneal endothelial profile was performed with Topcon computerized non-contact specular microscope (SP 3000) which included endothelium cell density (ECD), hexagonality (Hex.), cell number (CN), coefficient variance of cells size (CV), and central corneal thickness(CCT) before and one month after phacoemulsification. All phacoemulsification surgeries were performed by the same surgeon using same technique. The surgical technique included supero-temporal small incision with ultrasound energy that varied from 30-60 hertz per seconds depending on the cataract density.

Descriptive and comparative statistical analyses were performed using SPSS for Windows Version 21.0 (SPPS Inc., Chicago, IL, USA). All data were reported as means ± standard deviations (SD). A paired sample t-test was used to compare between variables pre and post-operatively. Independent sample t test was also used to compare means between different study groups. P value of < 0.05 was considered statistically significant.

RESULTS

A total 140 consecutive eyes of 140 patients who underwent phacoemulsification surgery were included in this study. Among them77 (55%) were males and 63 (45%) were females with mean age of 61.3 ± 9.3 years (range: 40 – 85). Mean best corrected visual acuity (BCVA), mean ECD, CV, Hex, CN and CCT before and after surgery are shown in table 1.

Using paired sample t test, mean BCVA was found significantly improved one-month post-surgery (0.72 ± 0.27) compared to that measured before operation (0.09 ± 0.14) with P value of < 0.001. Further analysis yielded no significant differences between both gender in term of mean age that was 61.6 ± 8.3 and 61 ± 10.5 for males and females respectively with P value of 0.72. Independent sample t test also showed no significant mean differences between males and females regarding pre-operative ECD, CN, Hex, CV and CCT with P values of 0.62, 0.67, 0.10, 0.56 and 0.17 respectively. The test also yielded no significant differences in all parameters evaluated between both gender post-operation with P value of > 0.05 (see table 2).

Table 1: *Pre-operative and Post-operative Comparison of Variables.*

Variable (N = 140)	Pre-operative Mean ± SD	Post-operative Mean ± SD	Average Changes %	P value
ECD (cells/mm^2)	2225 ± 469	1497 ± 670	32.7%	< 0.001
CN	58.6 ± 28	37.9 ± 24.8	35.3%	< 0.001
Hex (%)	42.7 ± 31.3	32.4 ± 23.1	24.1%	0.003
CV (%)	39.2 ± 9.5	40 ± 11.4	2%	0.55
CCT (µm)	481 ± 34	492 ± 41	2.3%	0.003

ECD = Endothelial cells density, CN = Cells number, Hex = Hexagonality, CV = Coefficient variation of endothelial cells size, CCT = Central corneal thickness.

Table 2: *Comparison of Variables among Male and Females.*

Variable	Pre-operative Mean ± SD			Post-operative Mean ± SD		
Gender (n = 140)	Males (n = 77)	Females (n = 63)	P value	Males (n = 77)	Females (n = 63)	P value
ECD (cells/mm^2)	2207 ± 465	2246 ± 476	0.62	1383 ± 516	1371 ± 541	0.89
CN	59.5 ± 28.4	57.4 ± 27.7	0.67	37.8 ± 25.8	38 ± 24.3	0.96
Hex (%)	38.8 ± 17.9	47.4 ± 41.9	0.10	31.6 ± 23.5	33.4 ± 22.6	0.65
CV (%)	38.8 ± 10.5	39.8 ± 8.01	0.56	40.5 ± 12	39.3 ± 10.7	0.55
CCT (µm)	484.6 ± 36.9	476.6 ± 29.9	0.17	494.3 ± 44.8	488.5 ± 36.9	0.41

ECD = Endothelial cells density, CN = Cells number, Hex = Hexagonality, CV = Coefficient variation of endothelial cells size, CCT = Central corneal thickness.

DISCUSSION

The corneal endothelium plays a crucial role in maintaining the dehydrated state and the transparency of the cornea.[3] Although, some degree of endothelial cell loss invariably occurs in all types of cataract surgery but the amount of endothelial cell loss varies according to the surgical technique.[4,5,6] Central corneal thickness and corneal endothelial cell density are the two important parameters in functional assessment of cornea for diagnostic purposes. Corneal endothelium cells have a limited capacity for repair, therefore damage to corneal endothelial cells is compensated by a combination of cell enlargement and cell spread to cover up for lost cells, resulting in a gradual decrease in endothelial cell density, which may lead to compromised functions of these cells.[6,7]

The results of the present study showed statistically significant decrease in endothelium cells density with a value of 32.7% for mean endothelial cell loss after phacoemulsification as compared to that assessed before the procedure. This reduction can be compared to several published studies that reported loss of 11.4% and 15.3%.[8,9] Several published studies conducted among different countries with different ethnic groups and various surgical techniques reported wide range of endothelial cell loss.[10-13] This higher loss affects the function of the endothelial cells, consequently the patients are at higher risk of corneal oedema after phacoemulsification surgery that finally leads to corneal opacity and visual impairment. The higher loss of endothelium cell in the current study could be attributed to difference in surgical technique, patient populations, and time points of evaluation after surgery, in addition tolower quality of materials, longer duration of surgery as well as inaccurate measurement because the study was conducted in poor nation with limited eye care resources. Ultrasound energy during phacoemulsification results in endothelial cell damage due to mechanical trauma from sonic waves and from thermal injury.[14]

In addition to endothelial cells loss, the hexagonal shape of individual endothelial cell is decreased with mean total loss of about 24.1% and the mean coefficient of variation of cell size is increased after phacoemulsification. These changes in shape and size are attributed to enlargement of endothelial cells in order to fill the gaps as a result of endothelium cell damage. Previous studies also support these findings. , this result in agreement with that reported in literature.[5,7]

The present study showed significant increase in mean central corneal thickness after phacoemulsification. This could be attributed to corneal oedema occurring as a result of changes in corneal endothelium. This finding is also in agreement with several previous reports.[13,14] The current increase in corneal thickness is higher compared to some studies conducted in Iran and Pakistan that reported an increase of 1.8% and 0.7% respectively.[8,15] On the other hand, other studies reported higher increase than

the current findings.[16] It has also been reported that besides the effect of phacoemulsification, postoperative cornel oedema could be due to many other factors such as patient's age, previous corneal pathology and a postoperative increase in intraocular pressure.[8,17,18]

The present study also showed no significant mean differences in term of endothelial cells changes between both gender, which is also found congruent with studies by others researchers.[19,20]

CONCLUSION

Phacoemulsification causes significant damage to corneal endothelial cells, resulting in reduced corneal endothelial cell density and hexagonality and also induces differences in cells size as well as corneal oedema.

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Ethical Approval

The study was approved by the Institutional review board/Ethical review board.

Conflict of Interest

Authors declared no conflict of interest.

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Disclaimer:

The corresponding author declares that the authors in this article had worked jointly in the same hospital when the study was conducted.

Authors' Designation and Contribution

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