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Original article

The Effect of Phaco Chop Cataract Surgery on Corneal Endothelium

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Abstract:

Aim: To evaluate the effect of Phaco Chop Cataract Surgery on Corneal Endothelium. **Setting**: Kasr Al-Ainy, university hospital, in the period between Aug-2021 to Feb-2022. **Methods**: A prospective study included 30-eyes that underwent cataract surgery using Phaco-chop technique. Endothelial cell loss (ECL) was correlated to effective phaco-time in seconds (EPT), age of the patients, and their gender 3-months postoperatively using specular microscopy. **Results**: This study was performed on 30 patients (17-cases were males, and 13-cases were females) who underwent phacoemulsification. Their ages ranged from 55 to 80 years, with a mean of 66.5 (± 6.54) years. The mean preoperative cell density (CD) was 2236 cell/mm^2, that decreased to 1597 cells/mm^2, 3-months postoperatively. This drop in CD was statistically significant ($p<0.001$). There was a significant positive correlation ($P<0.0001$) between ECL and EPT. Also, there was a significant positive correlation ($P<0.0001$) between EPT and cataract density. However, there was no correlation ($P=0.9316$) between ECL and age. Also, there was no correlation between ECL and gender ($P = 0.326$). There was significant improvement of visual acuity in all cases ($P < 0.0001$). **Conclusion**: Phaco Chop is an effective technique for cataract surgery. However, there was a significant effect on corneal endothelium. ECL was related EPT, which in turn was related type of senile cataract.

Key Words: Phaco chop , Corneal endothelium count, Cataract surgery.

Introduction:

Phacoemulsification represents the current procedure for Cataract surgery. Such type of surgeries is one of the most effective procedures to enhance patient's quality of life [(1)].

Cataract surgery may results in a significant change in corneal endothelial cells, leading to corneal oedema due to dysfunction of endothelial pump which may end in corneal opacity [(2)].

Endothelial cell damage is inevitable during phacoemulsification. Many factors are responsible, including cataract density, EPT, irrigation solution turbulence, whirling lens matter, intraocular lens, type of OVD, and intracameral pharmacological agents [(3)].

Corneal endothelial cells do not regenerate once they are damaged. However, the degree of such ECL varied in different studies and was related mostly to follow up time [(4-6)]. In this respect, specular microscopy is used as a non-invasive viewing and recording of the density and morphological changes of the corneal endothelial cells. ECL seems to continue for at least one year following cataract surgery and would be more than that of normal aging process [(6)].

Aim of the study:

To evaluate endothelial dysfunction after uncomplicated phaco-chop cataract surgery by assessment of CD and morphological changes of endothelial cells by specular microscopy.

Patients and methods:

Study design:

A prospective study including 30-eyes with senile cataract that underwent cataract surgery using Phaco-chop technique. ECL was correlated to EPT, type of cataract, age, and gender of the patients. It was carried out in Kasr Al-Ainy, university hospital, in the period between Aug-2021 to Feb-2022.

Ethical consideration:

We confirm that the participants' data were not used for any other purpose outside this study. All participants signed an informed consent in simple language before their inclusion in the study.

The study was approved by Faculty of Medicine-Helwan University Research Ethics Committee on 28 April 2021 by serial: 28-2021.

Inclusion criteria:

Age: 55-80 years. clear cornea, and endothelial count ≥ 2000 cells/ mm^2

Exclusion criteria :

1) Previous ocular surgeries, glaucoma, uveitis, retinal dystrophies, and retinal detachment.
2) Extremely hard cataract (grade 6 nuclear cataract on LOCS III scale), soft cataract, subluxated lenses or zonular dehiscence.

Methodology:

Preoperative:

full history taking, then patients were subject to:

1) An ophthalmic exam. to assess: BCVA, a slit-lamp bio microscopy of the anterior segment, IOP and examination of the fundus .
2) Biometry.
3) Specular microscopy was done before surgery and 3 months after surgery.

Corneal endothelial cell density and corneal thickness at the corneal apex were recorded by Konan noncontact specular microscope (Model SP-9000, Class-1, Japan).

Operative Technique: Following mydriatic-cycloplegic eyedrops; Peri-bulbar anesthesia was done 15 minutes before operation. All eyes were operated by same surgeon through superior clear corneal 2.4 mm incision. AC was filled with an ophthalmic visco-surgical device (OVD): optiflex (hydroxypropyl methylcellulose 2%). A capsulorhexis was performed using a cystitome. Phacoemulsification was done using the Phaco Chop technique using Infiniti machine (Manufactured by Alcon Laboratories Inc., USA). A single-piece foldable acrylic IOL was implanted after filling the bag with OVD.

Post-operative follows up: The patient was examined one-day, one week, one month, and three months, after surgery.

Main Outcome: Endothelial cell density before surgery and 3 months after surgery, EPT.

Statistical analysis:

The sample size was calculated to respect a significance of 0.05, confidence interval of 95% and power 80% and was found to be 30-eyes with senile cataract.

Data were analyzed using MedCalc® Statistical Software version 20.109 (MedCalc Software Ltd, Ostend, Belgium; https://www.medcalc.org; 2022). A p-value of < 0.05 was considered statistically significant.

Results:

This prospective observation study was performed on 30 eyes of 30 patients who had senile cataract and underwent phacoemulsification with foldable IOL implantation. 17-cases (65.7%) were males, and 13-cases (43.3%) were females. Their ages ranged from 55 to 80 years, with a mean of 66.5 (± 6.54) years. 18-eyes (60%) were Lt, and12-eyes (40%) were Rt (table-1).

Cases with ruptured posterior capsule and vitreous loss were excluded and randomly replaced by the next chronological patient.

The mean preoperative CD was 2236 that ranged from 2004 to 2532 cell/mm^2. However, it was decreased to 1597 with a range of 874 to 2440 cells/mm^2, 3-months postoperatively (Figure-1,2). This drop in CD was statistically significant (p<0.001).

Correlation between ECL and EPT:

There was a significant correlation (Correlation coefficient r: 0.9169, P<0.0001, 95% Confidence interval for r: 0.8311 to 0.9600) between ECL and EPT (Figure-3).

Correlation between EPT and Type of Cataract:

There was significant increase in effective phaco time with increased cataract density (Correlation coefficient r: 0.9654, P<0.0001, 95% Confidence interval for r: 0.9278 to 0.9836). It was noted that posterior subcapsular cataract, and nuclear cataract (N^1) have the same range of EPT. Also, both cases of cortical cataract and nuclear grade (N^2) possess the same vales of EPT. While nuclear grades N^3, N^4, and N^5 had a significant, progressive increase in EPT (Figure-4).

Correlation between ECL and age:

There was no correlation (Correlation coefficient r: -0.01636, P=0.9316, 95% Confidence interval for r: -0.3744 to 0.3460) between ECL and age (Figure 5).

Correlation between ECL and gender (Figure 6**):**

There was no correlation between ECL and gender (ANOVA; F-ratio: 1.001, P = 0.326, Shapiro-Wilk test for Normality: W=0.9665).

Improvement of visual acuity after cataract surgery:

There was significant improvement of visual acuity after cataract surgery by phacoemulsification in all cases (Two-tailed probability P < 0.0001). A statistically significant (P= 0.001) improvement in BCVA occurred postoperatively (figure 7).

The mean preoperative BCVA was 0.20 that ranged from 0.05 to 0.4, while the mean postoperative BCVA was 0.81 that range from 0.5 to1.0.

Table (1): Demographic Data of study cases

		Range	Mean ± SD
Age (years)		55-80	66.5 ± 6.54
Gender	**male**	17	65.7
	female	13	43.3
Laterality	**LT**	18	60
	RT	12	40

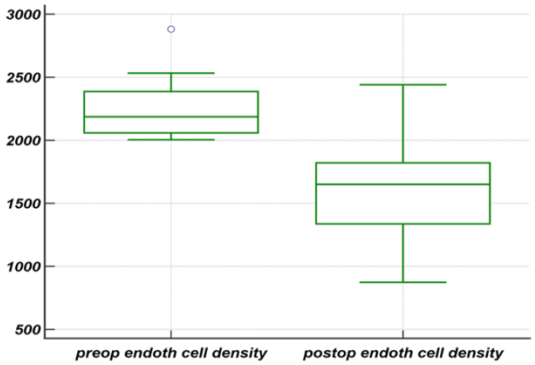
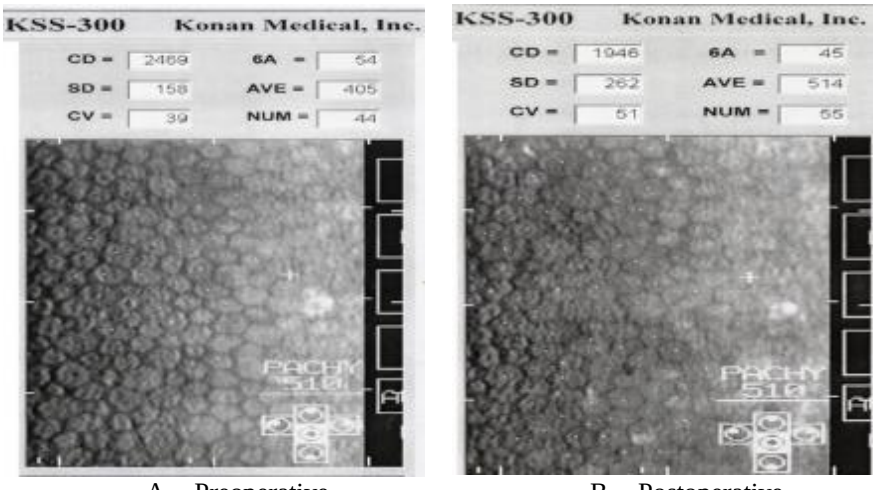


Fig. 1. Correlation between pre- & post-op endothelial cell density.



A- Preoperative B- Postoperative

Fig. 2: Endothelial Cell Density

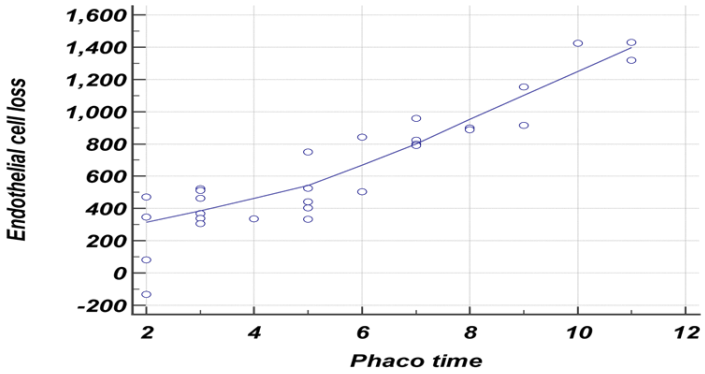


Fig. 3. Correlation between ECL and EPT.

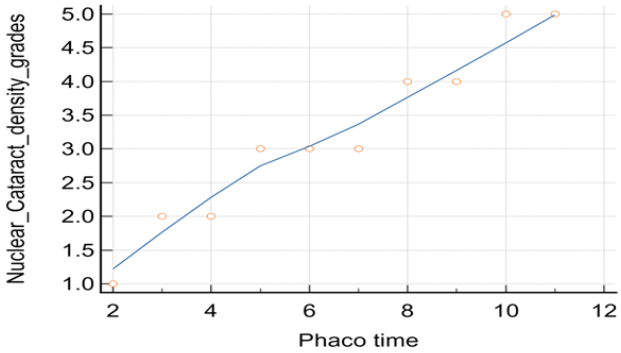


Figure 4. Correlation between EPT & Cataract density.

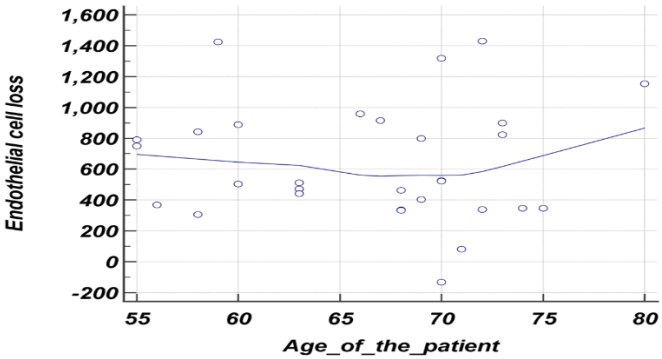


Figure 5. Correlation between ECL and age.

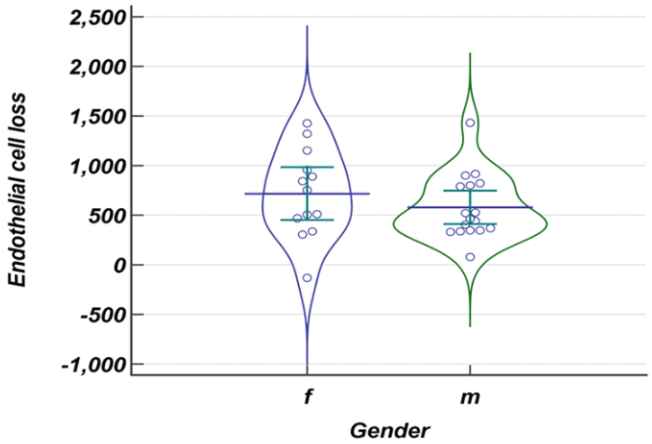


Fig. 6. Correlation between ECL and gender

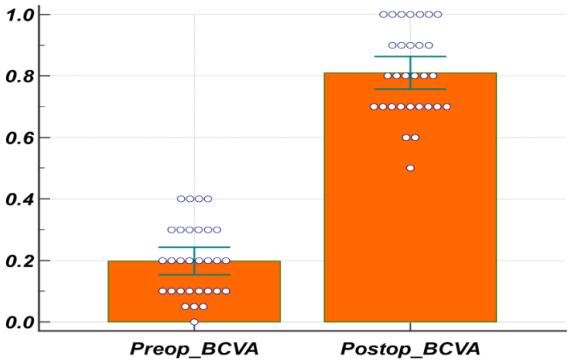


Fig. 7. Visual acuity after cataract surgery

Discussion:

The cornea is composed of six layers: epithelium, Bowman's layer, stroma, Dua's layer, Descemet's membrane, and endothelium. The stroma tends to swell under normal physiological conditions. This swelling is checked by active fluid pumping of the endothelium [(7)]. The endothelium cells do not regenerate with a limited capacity for repair, therefore its damage results in a gradual decrease in endothelial cell density, leading to dysfunction of these cells [(8)]. Assessment of endothelial cell morphology and density provides essential information concerning its viability and function. However, such data remains an anatomical not a functional evaluation. Furthermore, it covers a very small area of the central cornea [(9)].

The current study among Egyptian population showed that, the mean preoperative endothelial cell count was 2236 (± 204) cells/mm^2 with a mean age of 66.5 (± 6.54) years. It was less than values reported in Japanese age-matched group (61-70 years), where their mean cell count was 3307(±330), but it was higher than those in American, Indian, and Iranian population of the same age group (61-70 years), 2,684 (± 384), 2,431 (± 357) and 1,775 (± 348) respectively [10 & 11].

Phacoemulsification may affect the barrier function of the endothelium leading to ECL. The transient post-operative corneal edema that commonly occurs after phacoemulsification is probably due to endothelial cells damage [12]. Many factors may result in such injury, as direct mechanical trauma, ultrasound energy, and the irrigating solution [13]. Corneal complication represents an important injury as phacoemulsification is performed mostly in eyes with poor endothelial reserve [14].

The aim of this study was to explore the effect of uncomplicated phacoemulsification on endothelial cell density. We assessed the EPT on corneal ECL (EPT = phaco time X average phaco power).

The most important predictor of good visual result and a clear cornea is the amount of phaco energy delivered during the surgery. Current surgical techniques aimed at minimizing the effects of such phaco energy [15].

A direct correlation between phaco time and ECL was observed in the current study. Longer EPT and higher cataract density have been shown to be independent predictors for ECL. With advances in phaco power modulation, surgeons can effectively reduce the phaco time and power used in cataract surgery.[15] Some degree of ECL usually occurs in all types of cataract surgery, but its amount varies according to the surgical technique [16].

The results of the present study showed statistically significant decrease in mean endothelium cells density of 28.6% three months after phacoemulsification. This reduction could be compared to published data on ECL after cataract surgery that generally ranged from 4-25 % [17]. This variation in ECL could be related to post-operative period, where it was reported ECL of 5.2–9.1% 2-months after surgery [6]. Also, it was found a median ECL of 6.9% 3-months after cataract surgery [5]. Other investigators [18] reported mean ECL of

about 7.3% at 3 month and 10% after 1 year. Other coworkers reported ECL of 14% by 12-months [19]. This was in agreement with a previous study that reported ECL of 3.5–5.7% after12-months of follow up [4].

Our study reported that CD get stable 3-months following surgery. Corneal thickness returned nearly to normal values one-month after surgery, while endothelial loss continued. However, other investigators reported that CD persisted to decrease beyond 3-months, yet the rate of loss lessens with time [18]. Also, in another study a significant decrease in CD was revealed in both the short and long-term follow up [20].

Most studies agree that phacoemulsification results in qualitative and quantitative alterations at the corneal ECD. In this respect, ECL seems to continue at least for a year after cataract surgery and would be more than the normal aging process [6].

In addition, the present study showed that hexagonal-shaped cells were decreased with a mean total loss of about 28.6% and the mean coefficient of variation of cell size is increased. These changes in shape and size (morphological and morphometric alterations manifested by pleomorphism and polymegathism) after phacoemulsification are related to enlargement of endothelial cells to compensate for the gaps due to endothelium cell damage. Other studies also support these results [16 & 21].

Addition support to our study results, it was reported that it is important to follow up the significant differences evidenced on the CV in both pre- and post-operative follow-up visits since morphological changes have been observed in the corneal endothelium of the patients, including CD, percentage of hexagonality, and variation coefficient **[22].**

Cell loss increased significantly in patients with hard cataracts [18]. It was found that patients have a significantly lower ECD at all post-operative time points in relation to preoperative state, eyes with moderately hard senile cataract patients are subjected to various changes due to cataract extraction procedure [23].

The current study also pointed out that there was no significant differences as regards to endothelial cells changes between both gender, that came congruent with other studies [24]. However, other coworkers [25] found that the age factor is predisposing factor that affect the decrease in endothelial density after phacoemulsification**,** but our study revealed that age is only highly significant correlated to preoperative ECD without any relation to post-operative.

Visual acuity: there was A statistically significant (P= 0.001) improvement of visual acuity in all cases, where the mean preoperative BCVA was 0.20 that changed to 0.81 postoperatively.

other studies **[26],** showed significant improvement from preoperative visual acuity to postoperative visual acuity.

Conclusion:

Phaco Chop is an effective technique for cataract surgery. However, there was a significant effect on corneal endothelium. ECL was related EPT, which in turn was related type of senile cataract.

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