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# THE EFFECT OF PHACOEMULSIFICATION SURGERY ON CORNEAL ENDOTHELIUM

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## *ABSTRACT*

Introduction: Around half of world blindness and fifth of visual impairment are caused by cataract. Treatment of cataract and refractive errors correction improve 73.6% of blindness. Preservation of the Anterior chamber and corneal endothelium are very important aims during cataract surgery. Methodology: This prospective, observational study was done at King Fahd Hospital of the University (KFUH), Alkhobar, Saudi Arabia. After getting the Institutional Review Board (IRB) approval, the study was initiated at KFUH between April 2016 and August 2016. After getting the patients' informed consents, a thorough assessment was done to each patient prior to surgery. All eyes enrolled in the study have undergone phacoemulsification surgery procedure. For each patient, one month after the phacoemulsification surgery , specular microscopy was performed. The phacodynamic parameters and surgery time were compared with the degree of endothelial cells loss, hexagonality and central corneal thickness. Results: The phacodynamic parameters used during phacoemulsification, namely, power (AVG %), ultrasound time, and elliptical motion showed a strong correlation with the change of endothelial cell density (all P< .001). The length of surgery also showed a positive correlation with the amount of endothelial cell loss ( P < .001). All of these parameters did not significantly affect corneal endothelial hexagonality except elliptical motion. Change in central corneal thickness was very minimal. Conclusion: Endothelial loss was significantly associated with phacoemulsification power, ultrasound time, elliptical motion and length of surgery.

**Contribution/ Originality:** This study is one of very few studies which have investigated the effect of phacoemulsification cataract surgery on density and shape of corneal endothelial cells.

## 1. INTRODUCTION

The most common surgery done for American population above 65 years is cataract surgery [1] . Cataract is the most common cause of impaired vision in the world [2]. The prevalence of blindness in Saudi Arabia is 0.7% (52.6% due to cataract) and the prevalence of vision impairment is 10.9% (20.6% due to cataract). Treatment of cataract and refractive errors correction help 73.6% of blind subjects and 88.5% of visually handicapped population [3]. Recently, Cataract surgery has taken giant steps of improvement including new techniques, new instruments and the use of viscoelastics [4]. Phacoemulsification has become the most common cataract procedure since its

introduction in 1967 [5] Preservation of the eye's anatomy is a very important aim during cataract surgery so that patients can get the best benefit from cataract extraction [5, 6]. More concern is related to the protection of corneal endothelium [7-9] because this single layer of cells which plays an important role in preservation of corneal transparency [10] doesn't regenerate once damaged [11, 12]. Corneal Endothelial cell damage is mediated through prostaglandins which lead to significant inflammation and corneal swelling and increased thickness [13]. Factors that lead to corneal endothelial injury include the jackhammering effect of phaco cutting, implosion of air bubbles in the anterior chamber, the ultrasonic power fluctuation, bouncing of nuclear fragments, fluid turbulence and production of free radicals [14-17]. Irrigation pressure and temperature rise play their roles as well in harming corneal endothelial cells [18]. Surgeon's experience, hardness of cataract, type of corneal incision, age and preoperative visual acuity influenced endothelial cell loss as well [19]. Central endothelial cell count decreases by an average rate of 0.6% each year throughout life [20]. Specular is very useful tools for evaluation of corneal endothelium, with confocal microscopy showing more detailes about corneal endothelial histocytology [21, 22]. Corneal Endothelial loss occurs mostly at wound site, causing the surgically induced astigmatism [22] followed by the centre of the cornea. The purpose of this study was to detect the effect of phacoemulsification surgery on corneal endothelium.

## 2. SUBJECTS AND METHODS

This prospective, observational study was done at King Fahd Hospital of the University (KFUH), Alkhobar, Saudi Arabia. After getting the Institutional Review Board (IRB) approval, the study was initiated at KFUH between April 2016 and August 2016. All patients with symptomatic age-related nuclear cataracts who don't have any one of the following exclusion criteria were included: history of previous ocular surgery, diagnosed cases of glaucoma, clinical evidence of retinal disease on dilated fundus examination, diagnosed cases of uveitis, patients with endothelial cell count which is less than 1500, intraoperative complications that were shown to impact the endothelial cells. After getting the patients' informed consents, a thorough assessment was done to each patient prior to surgery. The assessment included corrected and uncorrected distance visual acuity, slit-lamp assessment, Goldmann applanation tonometry, fundoscopy, intraocular lens calculation, and three times specular microscopy with average endothelial cell count of all of the readings was taken. Patients' have signed on informed consents for undergoing phacoemulsification surgery on the same day of evaluation. All eyes enrolled in the study have undergone phacoemulsification surgery procedure, in which a 2.2 mm temporal clear corneal incision under local anesthesia with a stop and shop technique to divide the nucleus were used. All the cases have been done using the endocapsular phaco technique, and the mechanical breakdown of the nucleus also done inside the bag whenever is needed. A WHITESTAR Signature phacoemulsification apparatus (Abbot Medical Optics) implementing the Elliptical cutting pattern was used for phacoemulsification in the capsular bag. Measurements of the intraoperative power (AVG %), elliptical motion (EFX), and ultrasound time (UST) were taken, with theatre staff documenting the duration of the surgical procedure. For each patient, one month after the phacoemulsification surgery , specular microscopy (CEM-530, NIDEK CO., LTD.) was performed three times. In both situations, the average endothelial cells density has been chosen. The phacodynamic parameters and surgery time were compared with the degree of endothelial cells loss, hexagonality and central corneal thickness. SPSS was used for the statistical analysis. A P value of less than 0.05 was considered statistically significant, and all data were expressed as the mean ± standard deviation.

## 3. RESULTS

Of a study population of 175 patients, 96 were males (54.9%) and 79 were females (45.1%), with a mean age of 61.85 ± 9.12 years (range, 40 to 86 years).A total of 175 eyes (52.6% right eye and 47.4% left eye) were assessed in the study. Table 1 shows pre-operative and intra-operative parameters. Table 2 shows postoperative parameters.

Corneal Endothelial cell density preoperative was 2569 ± 344 cells and postoperative was 2119 ± 508 postoperative. Central corneal thickness was 550 ± 37 micromtere preoperative and 564 ± 40 micrometre. Mean hexagonality preoperative was 67% ± 11% and postoperative mean hexagonality was 64% ± 15%. Mean Corneal endothelial loss was 499 cells (17.4%) and mean difference in hexagonality was 2.5% and Central corneal thickness increased by a mean of 14.2 micrometer. Age and the phacodynamic parameters used during phacoemulsification, namely, power (AVG %), ultrasound time, and elliptical motion showed a strong positive linear correlation with the degree of endothelial cell loss ( all P< .001) (Figure 1 a-c). The length of surgery also showed a positive relashionship with the amount of endothelial cell damage ( P < .001) (Figure 1 d). None of the power, ultrasound time, surgery duration parameters have affected Hexagonality ( P 0.281, P 0.121, P 0.456 respectively). Only the Elleptical motion (P0.007). None of the parameters affected CCT significantly (P 0.209, P 0.117, P 0.919, P 0.175) for , power, ultrasound time, and elliptical motion and surgery duration respectively.

## 4. DISCUSSION

It is clear that the phacoemulsification surgery affects the corneal endothelium despite various protective measures including the use of ocular viscoelastic devices [23] mechanical chopping forces and emulsification in the posterior chamber. The presence of good endothelial cell count before the surgery makes prominent endothelial cell damage causing corneal decompensation and pseudophakic bollous keratopathy unlikely. Such serious changes can occur even long time after phacoemulsification because of the physiological decrease in corneal endothelial cell count by 0.6% each year. Factors most likely to lead to more endothelial cell damage include phacoemulsification power use and length of surgery.

In this study, The percentage of endothelial cell loss was (17.4%) more than what was detected by Xing, et al. [22] (12.4%) and Walkow, et al. [24] (11.9%). Change is corneal endothelial cells morphology was significant by confocal microscopy [22] but not by specular microscopy as in our study. Change in corneal thickness was minimal (2.5%) slightly more than 0.6% found by Salvi, et al. [25] and similar to vasavada et al (4.3%) and Sudeep et al (1.7%). The factors which have significantly affected corneal endothelium were phaco power and ultrasound time, and elliptical motion. They were also significantly associated with corneal endothelal cell loss in O'Brien, et al. [26] and Walkow, et al. [24] studies although some studies failed to show this correlation [27-29]. Phaco power and amount of elliptical motion are related to the hardness of cataract and ultrasound time is affected by the hardness of cataract and the surgeon's experience. Hardness of cataract and surgeon's experience were also significantly associated with endothelial loss in Orski, et al. [19] study. The use of Transverse (elliptical) motion machine was thought to be safer but it was shown that it provides no superior protection for corneal endothelium than the tortional [30, 31] although this doesn't apply to older tortional machines. Results also showed that as noted by previous studies, age was significantly associated with corneal endothelial loss as has been shown by Orski, et al. [19] although it is unmodifiable factor.

Fluidics and flow parameters were considered in other studies and showed that there was no significant effect on Central corneal thickness or corneal endothelial cell count [32, 33].

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