A COMPARATIVE STUDY OF CORNEAL ENDOTHELIAL CELL CHANGES AMONG DIABETIC AND NON DIABETIC PATIENTS AFTER PHACOEMULSIFICATION

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Abstract

Background: Diabetics have abnormal corneal morphology along with higher rate of corneal endothelial cell loss and decreased corneal endothelial cell density and early onset of cataract.

Aim: To evaluate the changes in corneal endothelium and corneal thickness in patients with diabetes mellitus after phacoemulsification Surgery .

Materials and Methods: Thirty eyes of 30 patients with Type 2 diabetes mellitus and 30 eyes of 30 age matched healthy cataractous patients underwent phacoemulsification surgery were evaluated. All the patients underwent specular microscopy for the corneal endothelial cell count of cornea and central corneal thickness pre-operatively, 3-4 weeks post-operatively. The morphology, variation in the endothelial size and shape and percentage of hexagonal cells were assessed.

Results: On comparing post-operative endothelial loss in non diabetics (3.04 ± 0.60 %) to diabetic group, the diabetic group had significantly higher endothelial loss (6.77 ± 1.69 % p<0.001). There was no significant difference in central corneal thickness in diabetics as compared to control (p = 395). The change in percentage hexagon cells in diabetic group was significantly higher than in non diabetic group (p =<0.001). Inter group change in coefficient of variance was statistically significant (p=<0.001).

Conclusion: Compared to non-diabetic patients, diabetic patients have more endothelial cells damage after phacoemulsification. Corneal endothelial evaluation of diabetic patients is recommended before any intraocular surgery.

Keywords: Corneal endothelium, Central corneal thickness

INTRODUCTION

Today, cataract is still one of the most important treatable causes of blindness worldwide. Phacoemulsification is currently the most commonly used procedure for cataract extraction. Ultrasound (US) power required for phacoemulsification continues to be a risk factor for endothelial cell loss and tissue damage.

Damage to the endothelium is potentially more serious than that to the other corneal layers and can result in cell loss and irreversible damage to the endothelial cytoskeleton, that ultimately affecting visual function. [(1)]

Surgical trauma during normal cataract surgery generally results in a 4% to 10% loss of endothelial cells. This postoperative cell loss is called iatrogenic endotheliopathy. In addition to the immediate cell loss associated with the procedure, cataract surgery also produces an accelerated rate of endothelial cell loss for at least 10 years after surgery. When too many cells are lost from iatrogenic endotheliopathy, endothelial function is compromised and postoperative corneal edema-develops.[(2-5)]

Corneal edema is one of the most frequent early postoperative complications of phacoemulsification, which can sometimes lead to permanent and serious visual disturbances. Postoperative corneal swelling and endothelial cell loss are related to many factors, including phacoemulsification time and energy, cataract density, corneal pathology, anterior chamber depth, axial length, ocular trauma, free radical development, mechanical and heat injury, phacoemulsification technique, experience of the surgeon, and use of viscoelastic material. [6-12]

A diabetic endothelium is morphologically abnormal and may be at risk for the change of the corneal endothelial cell morphology during cataract surgical procedures. [13]

Diabetic hyperglycemia inhibits NaC,KC-ATPase activity, influences the endothelial pump action, and finally induces the dysfunction of corneal endothelial cell layer with changes in the cellular morphology. [14]

It is likely that this phenomenon occurs because of chronic metabolic changes on the cellular level that primarily seems to affect the monolayer of corneal endothelial cells, these largely hexagonal cells are responsible for maintaining the desiccation of the stroma by actively removing the water and thus play a pivotal role in maintaining the clarity of the cornea, these cells have limited mitotic capacity, and a disturbance in the endothelial homeostasis might therefore have a profound effect on the clarity of the cornea.[15]

The site of the metabolic pump is within the lateral cell membrane, and it is a part of a completely formed junctional complex between the endothelial cells, the active transport pumping mechanism uses enzymes to translocate bicarbonate ions across the endothelial cell membrane, which passively permits water to follow the ions into the anterior chamber. [16]

Vogt was the first to image the endothelium in a living eye by modifying a Gullstrand slit-lamp, he visualized the endothelium by making use of the reflective property of the corneal-aqueous interface, with magnification of up to 68 times. Later, by improving on the same optical design, Laing was able to develop clinical specular microscopy with a magnification of up to 250 times. [17,18]

SUBJECTS AND METHODS

This prospective observational study included 60 consecutive cataractous eyes of 60 patients undergoing phacoemulsification through a 2.4 mm corneal incision. we included 30 patients for each group, group I (non-diabetic) and group II (diabetic). All surgeries were performed by the same surgeon at Alsafwa eye center from 11/2015 to 8/2016. Our study was conducted with the approval of the ethical committee of Alexandria University Faculty of Medicine. Informed consent was obtained from all patients enrolled in the study. The nuclear cataract grading was determined I to III according to the Lens Opacities Classification System II (LOCS) and confirmed by pentacam sceimpflug camera.

Inclusion criteria includes senile nuclear cataract Grade I and III and patients aged from 40 to 70 years, while Exclusion criteria includes endothelial corneal dystrophies e.g. fuch's dystrophy, or endothelial cell count less than (1200cells/mm2), complicated cataract, cataract with glaucoma, traumatic cataract, cataract with pseudoexfoliation, subluxated cataractous lens and lens induce glaucoma, grade IV and V nuclear Cataract, history of prior ocular surgery, diabetic retinopathy, any complicated case during surgery, e.g.: posterior capsular rent, zonullar dehecince, corneal disorders and ocular injuries, contact lens wearer, shallow anterior chamber. Preoperatively, all patients were subjected to history taking and examination (Visual acuity testing, Subjective refraction, Slitlamp examination of the cornea, Intra –ocular pressure readings by applanation tonometry and binocular indirect ophthalmoscopy for fundus examination), corneal endothelial cells were evaluated using specular microscopy (Nidek CEM-530, NIDEK, Japan). In each eye, central corneal thickness (CCT) number of cells per square mm (cell density), coefficient of variation of cell size (CV) and cell shape (hexagonality) were evaluated. Measuring depth of anterior chamber and cataract density using pentacam computerized scheimpflug camera. Operative procedure, all phacoemulsification surgeries done by the same surgeon using reproducible technique, preoperative instillation of topical gatifloxacin 0.3% eye drops 5 times one day before the day of operation, povidone-iodine application, draping, speculum, few drops of benoxinate HCL 0.4% were instilled before starting the operation then a small dose (0.2 mL) of preservative-free lidocaine hydrochloride (10 mg/mL 1%) is administered intra-camerally, main corneal incision was done using keratome 2.4mm and 2 side ports was done using super-blade, visco-elastic was injected in anterior chamber, central, circular and complete capsulorhexis was performed using cystotome and capsulorhexis forceps, hydro-dissection for separating the cortex from the bag, starting tortional phacoemulsification to divide and conquer the lens nucleus using Infiniti Vision System, Alcon, U.S.A, nucleus divided into 4 quarters where phaco-power was 30 % and the vacuum was 80 mmHg then emulsified under phaco-power 80 %, vacuum 300 mmHg, flow rate of 45cc/min and 90 cm bottle height, aspirating the cortex, implanting acrylic hydrophobic foldable IOL, closing corneal incisions by stromal hydration, the patients were instructed to use: topical moxifloxacin 0.3% eye drops 5 times daily for 2 weeks, topical prednisolone acetate1% eye drops 5 times/day for 1week, 4 times/day for a week, 3 times/day for a week, 2 times/day for a week then once/day for a week, nepafenac 0.1% Eye Drops 3 times/day for 2 weeks, follow-up examinations were performed on day 1, 3, 7 post-operatively for all patients by slit lamp to assess corneal edema, anterior chamber depth, cells and flares, intraocular pressure and the IOL position. Postoperative specular microscopy was done after 3-4 weeks post-operatively. In each eye central corneal thickness, number of cells per square mm (cell density), coefficient of variation of cell size and cell shape (hexagonality) were recorded.

Statistical Analysis

Data were fed to the computer and analyzed using IBM SPSS software package version 20.0. (SPSS) data were described using range (minimum and maximum), mean, standard deviation. Significance of the obtained results was judged at the 5% level. Tests used were; Chi-square test for categorical variables to compare between different groups, Fisher's Exact used for correction of chi-square when more than 20% of the cells have expected count less than 5, Student t-test for normally quantitative variables to compare between two studied groups, Paired t-test for normally quantitative variables to compare between two periods, Mann Whitney test for abnormally quantitative variables to compare between two studied groups, Wilcoxon signed ranks test for abnormally quantitative variables, to compare between two periods, Kruskal Wallis test is a non-parametric method for testing whether samples originate from the same distribution and ANOVA test is used to determine whether there are any statistically significant differences between the means of two or more independent groups.

RESULTS

The study included 60 patients, with 30 eyes in group I (non-diabetic) and 30 eyes in group II (diabetic). The baseline characteristics of the groups were similar, and the mean ages of the patients were 59.60 ± 7.53y and 57.87 ± 6.46y (*P*=0.342) in groups I and II, respectively. The mean nuclear lens density (NLD) grades were 15.49 ± 5.14 in the first group and 15.51 ± 5.02 in the second group (*P*=0.992). The preoperative mean best corrected visual acuities (Log mar) were 0.72 ± 0.35 in the first group and 0.80 ± 0.39 in the second group (*P*=0.366), and postoperative mean best corrected visual acuities were 0.03 ± 0.03 in the first group and 0.02 ± 0.03 in the second group (*P*=0.295). Preoperative intraocular pressures were 16.74±2.95 in the first group and 15.85±3.15 in the second group (*P*=0.483), and the postoperative intraocular pressures were 15.86±3.45 mm Hg in the first group and 14.92±2.78 mm Hg in the second group (*P*=0.497). In group I, the average ultrasound (U/S) power 28.97 ± 11.52 and cumulative dissipated energy (CDE) 5.83 ± 3.73, while in group II, the average ultrasound (U/S) power 29.80 ± 20.48 and cumulative dissipated energy (CDE) 6.22 ± 7.37. The mean of endothelial cells preoperatively was 2395.07 ± 322.30 while postoperative 2322.33 ± 313.08 in group I with a percentage of change ↓3.04 ± 0.60 %, while 2452.97 ± 294.61 preoperatively and 2286.90 ± 278.25 postoperatively in group II with a percentage of change ↓6.77 ± 1.69 % and there were statistically significant differences between the two groups (*P*=<0.001) figure 1. The mean of coefficient of variation preoperatively was 28.97 ± 4.77 while postoperative 30.70 ± 4.76 in group I with a percentage of change ↑6.16 ± 2.86 %, while 30.70 ± 6.98 preoperatively and 33.97 ± 7.24 postoperatively in group II with a percentage of change ↑11.12 ± 7.74 % and there were statistically significant differences between the two groups (*P*=<0.001) figure 2. The mean of endothelial cell hexagonality preoperatively was 69.53 ± 4.83 while postoperative 63.20 ± 5.02 in group I with a percentage of change ↓9.14 ± 2.78 %, while 69.07 ± 4.56 preoperatively and 60.70 ± 4.65 postoperatively in group II with a percentage of change ↓12.13 ± 3.07 % and there were statistically significant differences between the two groups (*P*=<0.001) figure 3. The mean of central corneal thickness preoperatively was 539.6 ± 40.51 while postoperative 549.07 ± 45.97 in group I with a percentage of change ↑1.76 ± 3.73 %, while 537.17 ± 27.79 preoperatively and 550.83 ± 30.90 postoperatively in group II with a percentage of change ↑2.58 ± 3.71 % and there were no statistically significant differences between the two groups (*P*=0.395) figure 4.

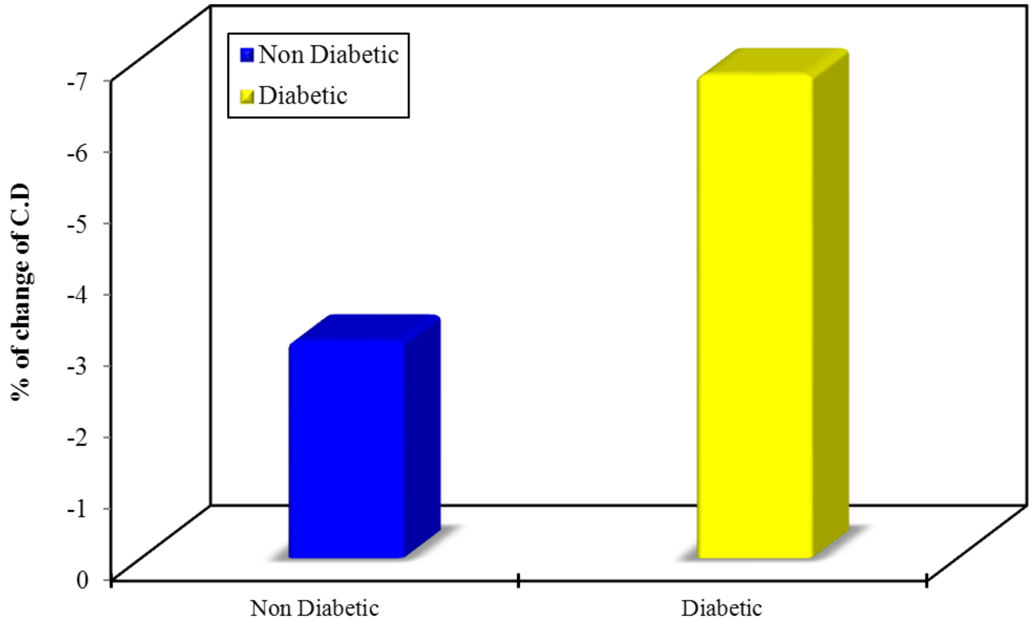

Figure (1): **Comparison between the non-diabetic and diabetic group according to percentage of change of C.D**

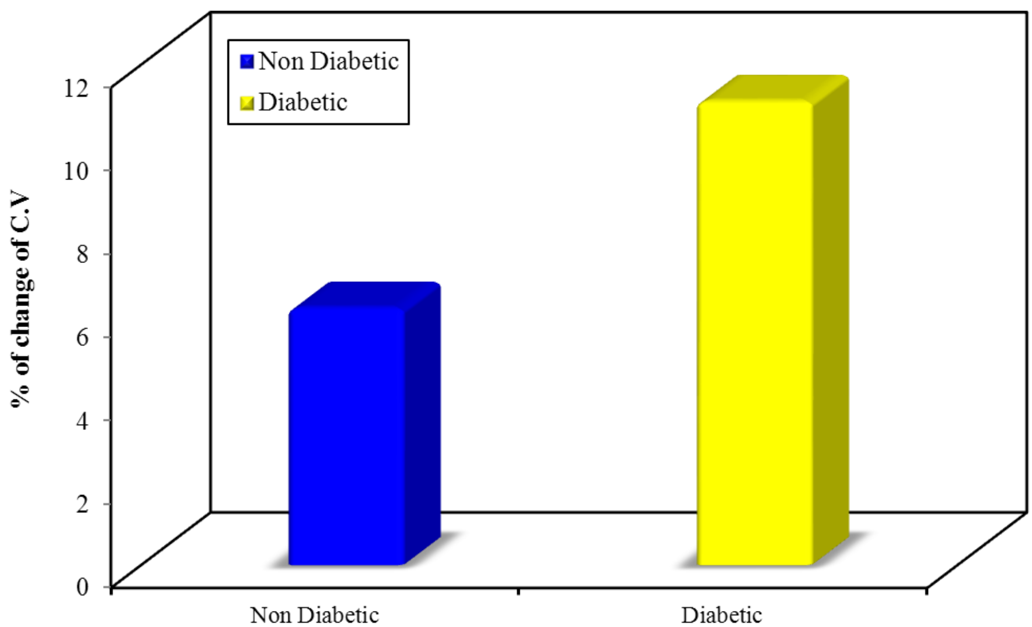

Figure (2): **Comparison between the non-diabetic and diabetic group according to % of change in C.V**

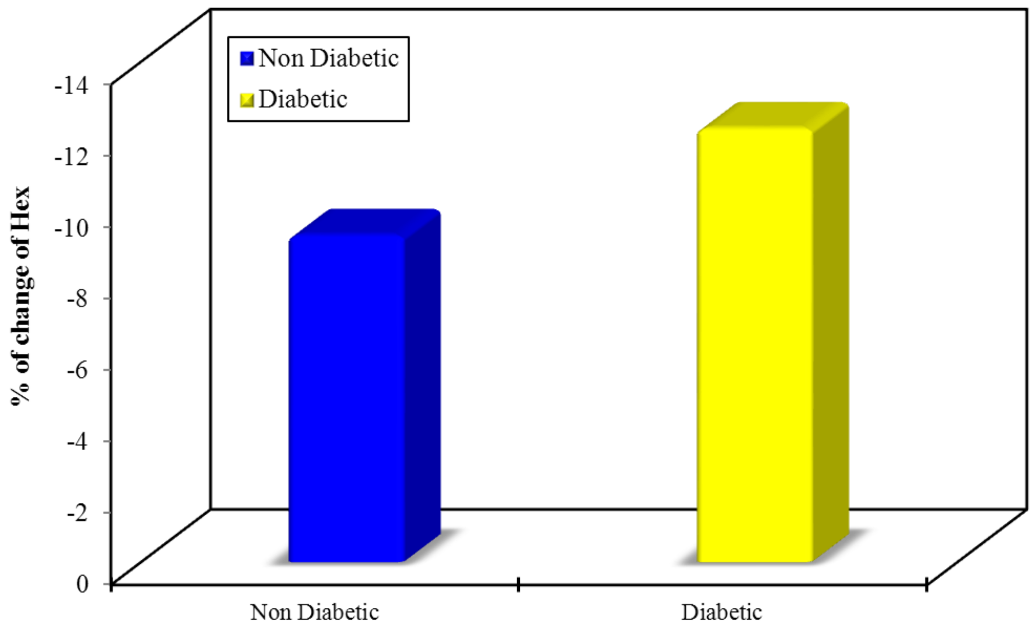

Figure (3): Comparison between non-diabetic and diabetic group according to % of change in Hex

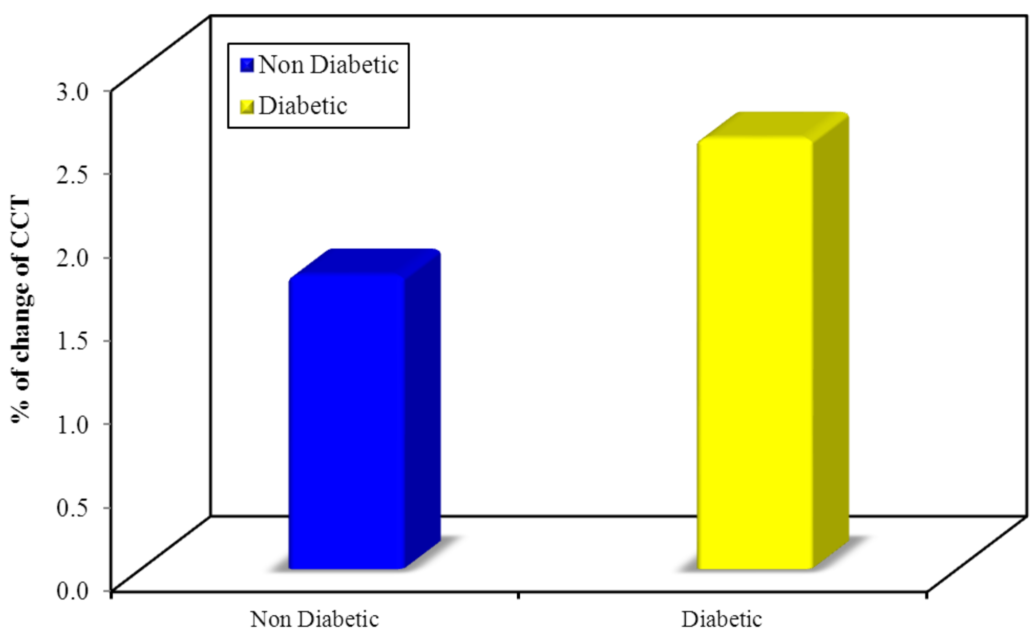

Figure (4): Comparison between the non-diabetic and diabetic group according to % of change CCT

DISCUSSION

In the present study there were statistically significant differences in CD, CV, CCT and endothelial cell hexagonality in diabetic group compared to non-diabetic one and these differences were more in the diabetic subjects.

Priya Thomas Mathew et al. [18] demonstrated that there was a drop in the endothelial density in the diabetic and non-diabetic groups at 6 weeks and 3 months postoperatively, this drop was significant and higher in the diabetic ones

Also recent studies by Osama Elbasiouny et al. [19] and J LIN et al. [20,21] showed similar results to ours, they demonstrated that before surgery, there were no statistical significant differences between the two groups in CCT, ECD, CV and percentage of hexagonal cell. Compared with pre-operative, CCT and CV increased post-operatively, while ECD and percentage of hexagonal cell decreased gradually. The CCT and CV in diabetic groups were significantly higher than in control group 1 week postoperatively, while ECD and the percentage of hexagonal cells were less than the control group cell at the same period.

Su et al.[22] designed a population-based, cross-sectional study including 3239 eyes and examined the relationship of diabetes and corneal endotheliam but in contradiction to our study there were no statistical significant difference in CV and endothelial cell hexagonality and this may be explained by the large cross sectional study used compared to our study.

Other study by Hugod M et al. [23] and demonstrated that there was a decrease in endothelial cell density at 3 months postoperatively more in diabetic than the control group. But in contradiction to our study there were no statistical significant differences in CV or CCT and may be this explained by the longer observation period in this study compared to ours which allows longer duration for corneal endothelium recovery.

Some other recent studies by Morikubo et al.[24] and Renu Dhasmana et al. [25] showed that there were significant difference in cell count between the 2 groups preoperatively then 1 month postoperative there was an increase in corneal thickness significantly higher in the diabetic group than in the non-diabetic group (P = 0.03), also endothelial cell losses were significantly higher in the diabetic group than in the non-diabetic group (P =0.04), while in contradiction to our study the coefficients of variation and percentage of hexagonal cells 1 month after operation were without significant differences between diabetic and non-diabetic groups and this is may be explained by the significant difference in cell count between the 2 groups preoperatively.

Aim of the work

The present study aims at comparing the endothelial changes after phacoemulsification for senile cataract in non-diabetic and diabetic patients.

Summary

Our study compared the effect of diabetes on corneal. There was no a statistically significant difference in the central corneal thickness between the 2 groups, there was a statistically significant difference in CD, CV endothelial cell hexagobality.

Senile cataract is one of the leading causes of reversible blindness in elders. Cataract surgery and IOL implantation is considered the definitive treatment. Cataract surgery went through many modifications from intra-capsular cataract extraction to extracapsular cataract extraction to phacoemulsification.

Since Kelman in 1967 introduced Phacoemulsification, it has now been accepted as gold standard surgical procedure for management of cataract, and since then many modifications were done aiming at making cataract surgery not only a simple procedure to remove the opaque lens, but also to achieve the best possible visual outcome with optimal safety and minimum invasiveness.

Corneal edema is one of the most frequent early postoperative complications of phacoemulsification due to endothelial cell loss.

In this study we aimed to compare the effect of diabetes on corneal endothelium by assessing preoperative and postoperative endothelial cell count and compare it to the control group, also to assess the effect of cataract density on corneal endothelium.

The study was conducted on 60 eyes scheduled for phacoemulsification and IOL implantation. Patients were selected and assigned into two major groups, group (I) non-diabetic, and group (II) diabetic each of the 2 groups further subdivided into 2 subgroups according to cataract density into group a and b. Phacoemulsification was done for all study participants with informed consent was obtained from them.

CONCLUSIONS

- In conclusion, phacoemulsification has a major influence on corneal endothelium more significant in diabetic patients than in non-diabetic ones, while cataract density has a major role mainly on endothelial cell loss during phacoemulsification.
- Further randomized controlled trials with larger sample sizes are needed to validate these observations.
- Longer follow up time is needed to give more predictable results.

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