Central Corneal Thickness Before And After Phacoemulsification In Non-Diabetic And Diabetic Patients Without Retinopathy

Raga abdeldayem abdelhalem, Mohamed Yasser Sayed Saif, sahar Ibrahim Mohamed

Ophthalmology department, Faculty of Medicine, Beni-Suef University, Beni Suef , Egypt

Abstract

Background: Corneal thickness is a sensitive indicator of the health of the cornea and serves as an index for corneal hydration and metabolism. It is an important indicator of patency of the corneal endothelial pump. Corneal endothelial damage following phacoemulsification is still one of the major concerns of modern day cataract surgery. Although many techniques have been proposed, the risks of posterior capsular rupture and corneal endothelium damage persist.

Aim of the Work: This study was designed to assess the effect of phacoemulsification on central corneal thickness measured by anterior segment OCT in non-diabetic and diabetic patients.

Methods: Our study included 20 cases subdivided into 2 groups: 10 cases normal (non-diabetic) and 10 cases diabetic without retinopathy ranged from 18 to 60 years, with a mean age of 56.50 years in the non-diabetic group and 55.70 years in the diabetic without retinopathy group. SD in non- diabetic group ± 2.22, in the diabetic without retinopathy group ±3.13, p = 0.518, in the normal non- diabetic group 7 cases (70.0 %) were men and 3 cases (30.0%) were women. In the diabetic without retinopathy group, 6 cases (60.0%) were men and 4 cases (40.0%) were women.

In the non- diabetic group, the mean average CCT was 500.80 ± 23.73µm before phaco, 508.90 ± 28.33µm 0ne week after phaco with P = 0.021 and 501.10 ± 24.33µm one month after phaco with P = 0.011. In the diabetic without retinopathy group, the mean average CCT was 508.50 ±6.75µm before phaco ,535.20 ±16.98µm one week after phaco with P = 0.021 and 527.60 ±16.63 µm one month after phaco with P = 0.011.

Results: There was found a significant change in CCT after phacoemulsification in both diabetic and non-diabetic groups, and the eyes of patients with diabetes mellitus showed a delay in the postoperative recovery of corneal edema compared with non-diabetic eyes.

Conclusion: Patients with diabetes have significantly more endothelial damage and more corneal edema in comparison to non-diabetic controls with similar nuclear grading and phaco energy used.

Keywords: *Central corneal thickness, phacoemulsification, diabetes*

1. Introduction:

The cornea has five layers: corneal epithelium, Bowman's layer, Corneal stromal, Descemet's membrane and Corneal endothelium **(1)**.
possibly six if Dua's layer is included just anterior to Descemet's membare **(2).**

Endothelial cells of the cornea maintain this tissue in a dehydrated state by their pumping activity, thereby assuring its transparency .This is an active process that is controlled by Na+/K+-ATPase and involves the generation of a bicarbonate ion gradient across the corneal endothelium.

When energy is deficient, the pump may fail or works too slowly to compensate, causing swelling. The endothelium controls this pumping action, and damage therefor is more serious, and is a cause of opaqueness and swelling.

Optical coherence tomography (OCT) is a high-resolution, cross-sectional imaging modality initially developed for retinal imaging. Anterior segment OCT (ASOCT)

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imaging was first described in 1994 by Izatt et al. using the same wavelength of light as retinal OCT, namely 830nm. **(3).**

This wavelength is suboptimal for imaging the angle due to limited penetration through scattering tissue such as the sclera. OCT imaging of the anterior segment with a longer wavelength of 1310nm was developed later on and had the advantages of better penetration through the sclera as well as real-time imaging at 8 frames per second **(4).**

With the development of Fourier domain OCT (FDOCT) technology, real-time imaging of the posterior segment has also become feasible. Several retinal FDOCT devices allow imaging of the anterior segment; however, they still use the shorter wavelength of 830-870nm with its inherent disadvantages in imaging the AC angle.

The higher resolution provided by FD retinal OCT devices does have advantages in imaging other structures in the anterior segment, such as the cornea and conjunctiva. Fourier- domain OCT devices operating at longer wavelengths suited for AC angle imaging have also been described **(5)**.

During cataract surgery, several mechanisms may lead to endothelial injury, including direct trauma from instruments ultrasound energy from phacoemulsification, and irrigation fluid turbulence. Despite the use of viscoelastics , corneal edema is one of the most common complications after cataract extraction.

Corneal thickness is a sensitive indicator of the health of the cornea and serves as an index for corneal hydration and metabolism. It is an important indicator of patency of the corneal endothelial pump.

Corneal endothelial damage following phacoemulsification is still one of the major concerns of modern day cataract surgery. Although many techniques have been proposed, the risks of posterior capsular rupture and corneal endothelium damage persist. **(6)**

In theory, damage to the corneal endothelium is minimized by delivering the lowest phaco energy only in the direction necessary to emulsify the lens nucleus.

Hence, it is believed that the bevel of the needle should be turned towards the nucleus or the nuclear fragment (i.e., bevel-down)

However, there is a different opinion among ophthalmologists with reference to the phaco tip's position (bevel-up vs. bevel-down) during phacoemulsification (**6).**

Despite good glycemic control, patients with diabetes have significantly more endothelial damage in comparison to non-diabetic controls with similar nuclear grading and phaco energy used. This warrants more careful use of the phaco energy in patients with diabetes. **(7).**

2. Patients and Methods:

This longitudinal descriptive study was conducted at Al Fayoum Ophthalmic Hospital & Beni Suef University, involving 20 cases subdivided into 2 groups: 10 normal cases and 10 cases diabetic without retinopathy within four months between March and June 2018 and verbal consent was obtained.

2.1 Inclusion criteria:

Clear corneas in non- diabetic and diabetic patients without retinopathy.

Age 18-60 years old.

Nuclear grade 2 or cortical cataracts.

2.2 Exclusion criteria:

Corneal opacities.

Ocular and systemic diseases affect corneal thickness.

2.3 All patients were subjected to:

All participants were subjected to an ophthalmological examination.

- vision assessment with a snellen chart.
- Autoref.
- Anterior segment examination of the slit lamp.
- Biomicroscopy examination a 90D lens.
- Intraocular pressure.
- Anterior segment OCT using Optovue before phaco and after phaco (After one week and one month).

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Then phacoemulsification by the same surgeon using the same technique.

Phaco steps:

1-Main corneal incision by Keratom and 2 side ports by MVR.

2-A viscoelastic fluid (Healon GV& methyl cellulose) is injected to reduce shock to the intraocular tissues.

3-staining of the anterior capsule by Trypan blue stain.

4-Microscopic circular incision in the membrane that surrounds the cataract (capsulorhexis).

5- A water stream then frees the cataract from the cortex.

6- Phacoemulsification of the nucleus (by the Stop and chop technique) .

7-Removal of the cortex of the lens.

8-The folded IOL is inserted by an injector.

9-After the IOL is inserted into the capsular bag, the viscoelastic fluid is removed.

Post-operative treatment and follow-up

Antibiotic (topical eye drops and systemic capsules)

Steroid topical eye drops

Follow up in the next visits (after one week and one month) for assessment of central corneal thickness by anterior segment OCT.

Statistical methodology

- Approval was obtained from the Institutional Review Board (IRB) of Beni-Suef University prior to starting data collection.

-Data were analyzed using SPSS version 22; bivariate analysis done using suitable statistical tests; results were considered significant for p-values less than 0.05.

- Data were coded and entered using the statistical package SPSS (Statistical Package for the Social Sciences) version 25. Data were summarized using mean and standard deviation in quantitative data and using frequency (count) and relative frequency (percentage) for categorical data.

- Comparisons between quantitative variables were done using the unpaired t test **(8)**.

- For comparison of serial measurements within each group repeated measures ANOVA was used **(9)**.

- For comparing categorical data, Chi square (2) test was performed. The exact test was used instead when the expected frequency was less than 5 **(10)**. P-values less than 0.05 were considered statistically significant.

• P value > 0.05 insignificant

• P < 0.05 significant

• P < 0.01 highly significant

3. Results

-The current study was conducted at the Al Fayoum Ophthalmic Hospital and Beni-Suef University. Within four months of March and June 2018. The total tonumber of subjects meeting the criteria was 20 who underwent anterior segment OCT assessment for central corneal thickness before and after phacoemulsification (one week and one month).

-The studied eyes were of two groups: the normal non- diabetic group and diabetic patient without retinopathy group. All patients were aged 18- 60 years old.

Age:

The age of our studied subjects ranged from 18 to 60 years, with mean age 56.50± 2.22 years in the non-diabetic group and 55.70 ±3.13 years in the diabetic without retinopathy group. With p = 0.518.

	Non- diabetic patients		**Diabetic without retinopathy**		
	Mean	**Standard Deviation**	**Mean**	**Standard Deviation**	**P value**
Age	56.50	2.22	55.70	3.13	0.518

Table 1. Distribution according age groups

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Gender:

Our study included 10 patients in the non-diabetic group: 7 cases (70.0 %) were male, 3 cases (30.0%) were female and 10 diabetic without retinopathy group: 6 cases (60.0%) were male and 4 cases (40.0%) were female with p = 1.

		Non- diabetic patients		Diabetic without retinopathy		P value
		Count	%	Count	%	
Gender	Female	3	30.0%	4	40.0%	1
	Male	7	70.0%	6	60.0%	

Table 2. Distribution according gender groups

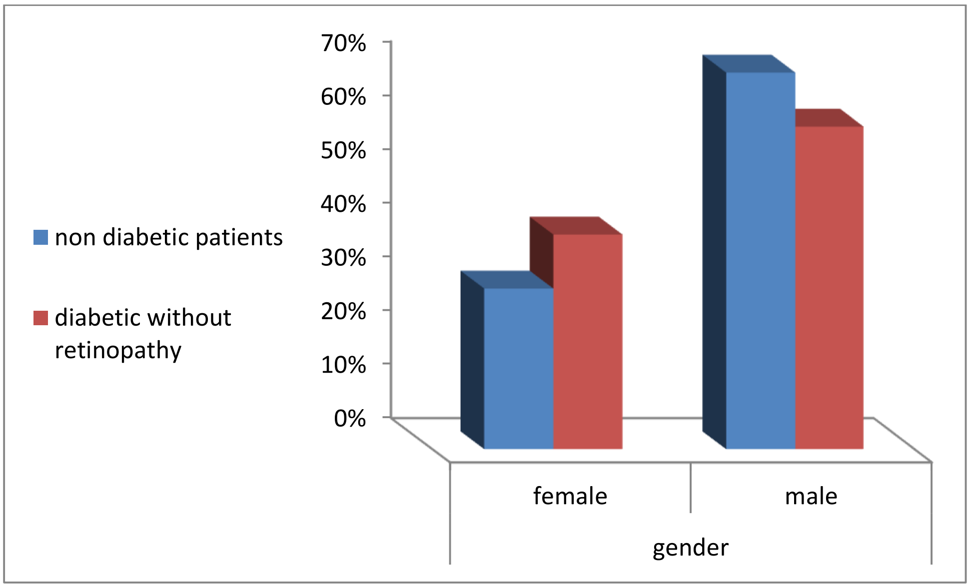

Fig.16: Distribution according to gender group

3-

The CCT in both non-diabetic and diabetic without retinopathy groups before and after phaco

In the non-diabetic group the mean average CCT was 500.80 ± 23.73µm before phaco, 508.90 ± 28.33µm One week after phaco with P= 0.021 and 501.10 ±24.33µm one month after phaco with P = 0.011.

In the diabetic without retinopathy group, the mean average CCT was 508.50 ±6.75µm before phaco, 535.20 ±16.98µm one week after phaco with P =0.021 and 527.60 ±16.63 µm one month after phaco with P value 0.011.

<u>Comparison between groups</u>

The following graphs (Graphs 17, 18 and 19) and table (Table 3) show the CCT before and after phaco (after one week and one month). There was a significant change in CCT in both groups after phaco, after one week with P value =0.021 and one month with P value = 0.011.

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	Non-diabetic patients		Diabetic without retinopathy		
	Mean	Standard Deviation	Mean	Standard Deviation	P value
CCT before phaco	500.80	23.73	508.50	6.75	0.346
CCT after 1 week	508.90	28.33	535.20	16.98	0.021
after 1 month	501.10	24.33	527.60	16.63	0.011

Table (3): Changes in CCT before surgery and after 1st week and 1st month in diabetic and non-diabetic patients.

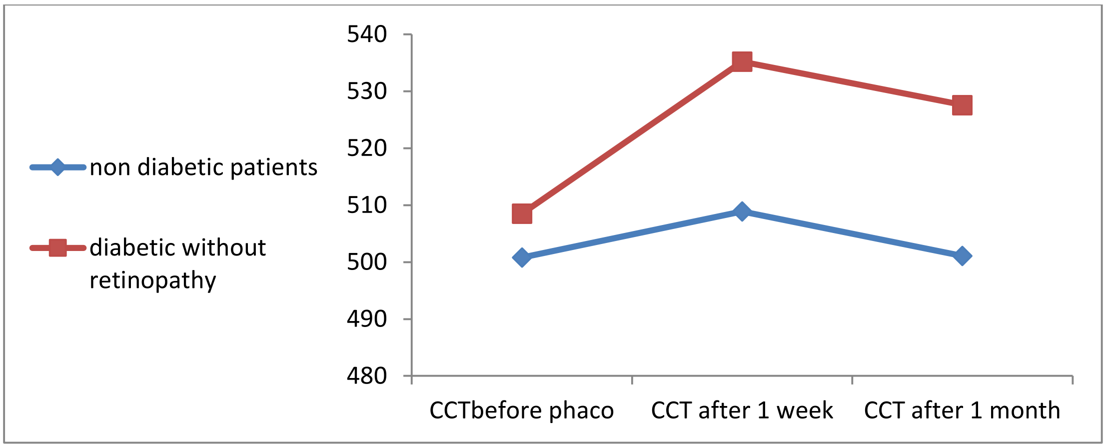

Fig. 17: Changes in CCT before surgery, after 1st week and 1st month in diabetic and non-diabetic patients.

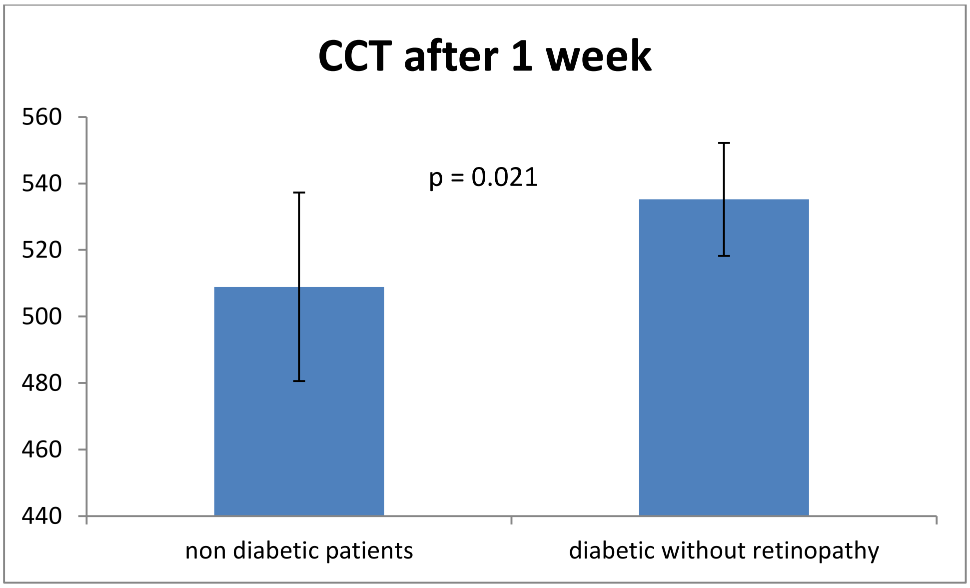

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Fig.18: Changes in CCT after the 1st week in diabetic and non-diabetic patients.

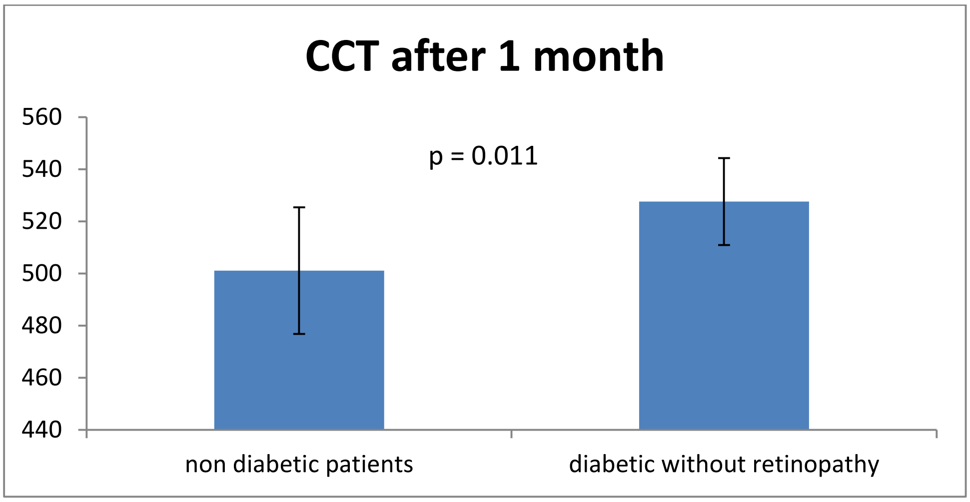

Fig.19: Changes in CCT after one month in diabetic and non-diabetic patients

Comparison over time in each group

It was found that there was a significant delay in the recovery of CCT one month after phaco in the diabetic group compared to the non-diabetic , P= 1 in the non-diabetic group and p =0.040 in the diabetic group.

The change in CCT between the first and fourth weeks was significantly higher in the diabetic group (P = 0.040).

	Non- diabetic patients		**P value compared to before**
	Mean	**Standard Deviation**	
CCT before phaco	500.80	23.73	---
CCT after 1 week	508.90	28.33	0.003
after 1 month	501.10	24.33	1

Table (4): Changes in CCT before surgery and after 1st week and 1st month in non- diabetic patients.

	Diabetic without retinopathy		**P value compared to before**
	Mean	**Standard Deviation**	
CCT before phaco	508.50	6.75	---
CCT after 1 week	535.20	16.98	0.011
after 1 month	527.60	16.63	0.040

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Table (5): Changes in CCT before surgery and after 1st week and 1st month in diabetic and non-diabetic patients

4.

Discussion

Several studies have revealed a significant change in central corneal thickness after phacoemulsification.

Concerning postoperative changes, the increase in central corneal thickness was highest 1 day after operation among the 3 time points measured in the diabetic and non-diabetic groups, but recovered thereafter. However, the recovery rate was slower in the diabetic group than in the non-diabetic group. The increase in central corneal thickness 1 month after surgery was 0.04% in the non-diabetic group and 1.6% in the diabetic group, showing significantly poor recovery in the latter.

Therefore, recovery of corneal edema after cataract surgery may be delayed in the cornea of diabetic patients, as the corneal thickness will not have returned to the preoperative level 1 month after surgery. **(11)**

In Mathew 2011 (12), consecutive patients with diabetes (153) in the age group 40-70 years and age-matched patients without diabetes (163) undergoing manual SICS were enrolled. Preoperative and 1 week, 6 weeks, and 3 months post-surgery assessments of corneal endothelial loss and change in CCT were done using specular microscopy and ultrasound pachymetry.

There was a steady drop in the endothelial density in both groups postoperatively, with the percentage of endothelial loss at 6 weeks and 3 months being 9.26 ± 9.55 and 19.24 ± 11.57, respectively, in patients with diabetes and 7.67 ± 9.2 and 16.58 ± 12.9, respectively, in controls.

The percentage of loss between 6 weeks and 3 months was found to be significantly different ($P < 0.023$). In both groups, an initial increase in CCT until the second postoperative week was followed by a reduction of CCT in the subsequent follow-up (sixth week) and a further reduction in the last follow-up (3 months). The change in CCT between the second and sixth weeks was significantly higher in the diabetic group.

($P = 0.045$).

Sahu 2017(13) compared the corneal endothelial status in sixty patients with diabetes with good glycemic control and sixty non-diabetic controls before and after (1 week, 1 month, 2 months, and 3 months) uneventful phacoemulsification. Central corneal endothelial cell density, percentage hexagonality, and coefficient of variation were measured using a noncontact specular microscope. Central corneal thickness was taken as a surrogate marker for endothelium functional status.

Data were age- and sex-matched. Patients with diabetes showed significantly higher loss of endothelial cell count as compared to non-diabetic controls. Furthermore, the patients with diabetes showed a slower recovery trend in the endothelial healing response, as evidenced by the lower change in the coefficient of variation and slower recovery in corneal edema after phaco. A significant correlation was found between energy use and change in endothelial count as well as coefficient of variation in non-diabetics only.

In Terrence 2007(14), Thirteen consecutive patients who had uneventful phacoemulsification surgery by the same

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experienced surgeon were prospectively evaluated for CCT measurements 1 hour preoperatively and 1 hour, 1 day, and 1 week postoperatively.

The unoperated eye also had CCT measurements simultaneously on all occasions and served as a control. The mean age of the patients was 69 years. The central corneal thickness was 550.34 µm preoperatively, 626.39 µm at 1 hour, 585.80 µm at 1 day, and 553.80 µm at 1 week. In the control group, CCT remained stable, within ±2 µm of preoperative readings.

It was found that Central corneal thickness increased by approximately 13.81% in the immediate postoperative period (at 1 hour). It remained increased by 6.44% on day 1 compared with preoperative values and gradually reduced to preoperative levels by the 1-week postoperative period (0.57% difference).

In our study, we found a significant change in CCT after phaco in both diabetic and non-diabetic groups .The significant increase in CCT one week after phaco due to corneal edema which recover gradually

We also noticed that the eyes of patients with diabetes mellitus showed a delay in the postoperative recovery of corneal edema compared with non-diabetic eyes, as we noticed CCT one month after phaco **.**

In non-diabetic group, the mean average CCT was 500.80 ±23.73µm before phaco, 508.90 ±28.33µm 0ne week after phaco (P = 0.021) and 501.10 ±24.33µm one month after phaco (P = 0.011).

In the diabetic without retinopathy group, the mean average CCT was 508.50 ±6.75µm before phaco, 535.20 ±16.98µm one week after phaco (P = 0.021) and 527.60 ±16.63µm one month after phaco (P = 0.011).

Therefore, recovery of corneal edema after cataract surgery may be delayed in the cornea of diabetic patients, as the corneal thickness will not have returned to the preoperative level 1 month after surgery.

5. Conclusion

It was found that there was a significant change in CCT after phaco in the diabetic and non -diabetic groups.

Also there was a significant delay in the recovery of CCT one month after phaco in the diabetic group compared to the non-diabetic.

The change in CCT between the first and fourth weeks was significantly higher in the diabetic group.

The recovery of corneal edema after cataract surgery may be delayed in the cornea of diabetic patients, as the corneal thickness will not have returned to the preoperative level 1 month after surgery.

This suggests that the eyes of diabetic patients may be under metabolic stress and have corneal endothelium with lower reserve ability than non-diabetic eyes.

Recommendations:

Our study suggests that, in spite of good glycemic control, patients with diabetes have significantly more endothelial damage and more corneal edema in comparison to non-diabetic controls with similar nuclear grading and phaco energy used. This warrants more careful use of the phaco energy in patients with diabetes.

6. Summary

Phacoemulsification affects central corneal thickness as there is a significant corneal edema after phaco, which resolves gradually but delays in the recovery of corneal edema after phaco in the diabetic group compared to the non-diabetic group.

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The recovery of corneal edema after phaco may be delayed in the cornea of diabetic patients, as the corneal thickness will not have returned to the preoperative level 1 month after surgery.

Patients with diabetes have significantly more endothelial damage and more corneal edema in comparison to non-diabetic controls with similar nuclear grading and phaco energy used. This warrants more careful use of the phaco energy in patients with diabetes.

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