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Evaluation of macular thickness after uncomplicated cataract surgery using optical coherence tomography

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Abstract: Purpose: To determine macular thickness changes after uncomplicated cataract surgery using spectral domain optical coherence tomography (OCT). **Methods:** This was a prospective clinical study. Data were analyzed for 38 patients undergoing uneventful phacoemulsification. Complete ophthalmological evaluation was done preoperatively. OCT measurements were performed before surgery and postoperatively at day 60. CMT was measured at days 1 & 60 postoperatively. **Results: Postoperative** day 60 CMT was significantly thicker than CMT in preoperative assessment (P>0.05). There was no significant correlation between CMT changes and preoperative BCVA or postoperative BCVA. **Conclusion:** The present study demonstrated a significant increase in post operative CMT after uncomplicated cataract surgery. However it is mostly innocent and not affecting the BCVA.
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Keywords: Evaluation； macular； thickness； uncomplicated cataract surgery；optical coherence tomography

1. Introduction

One of the important common causes for unfavorable visual outcome after cataract surgery is pseudophakic cystoid macular edema (PCME). Although the incidence of PCME has decreased due to the improvement in the cataract surgery from intracapsular cataract extraction to phacoemulsification combined with microincisional techniques and in bag placement of intraocular lenses, PCME is still reported in the pseudophakic eyes. ***(chaudhary et al., 2015)***

Pseudophakic cystoid macular edema was first described by *Irvine* after intracapsular cataract extraction (ICCE) in 1953. Development of clinically significant CME, with a decrease in the visual acuity, following modern cataract surgery has been reported at a rate from 0.2% to 14%. ***(Şahin et al., 2013)***

Optical Coherence Tomography is a noncontact, noninvasive technique that allows frequent measurements of the retinal thickness and is well tolerated by the patients at the most. It has a high degree of reproducibility and repeatability. ***(Georgopoulos et al., 2008)***

The possible causes that may contribute to cause the post operative cystoid macular oedema (CMO) are: the type of cataract surgery, light toxicity, vitreomacular traction, inflammatory mediators, use of adrenergic drugs, age, vitreous loss, the integrity of the posterior capsule, hypertension, and diabetes. **(*Ursell et al., 1999*)。**

2. Patients and methods

Patients:

This was a prospective non controlled study was conducted on patients admitted to the ophthalmology department in Menofia University hospital from January 2016 the end of collection of cases and their follow up at June 2017.

This study included 38 eyes of 38 patients who were subjected to phacoemulsification and intraocular lens (IOL) implantation. Before the procedure, a written informed consent was signed from every patient.

Inclusion criteria:

- Patients age from 40 years up to 72 years with cataract causing visual impairment.
- Uncomplicated phacoemulsification.

Exclusion criteria:

- Complicated phacoemulsification.
- Significant ocular disease as: uveitis or glaucoma.
- Previous ocular surgery (retinal detachment or pervious ocular surgery) or pervious ocular trauma.
- -Any systemic disease or any medication (topical or systemic) may cause alteration in central macular thickness.
- -Fundus pathology (diabetic retinopathy, age related macular degeneration or pathological myopia).
- -Low quality or unreliable OCT.

2. Methodology:

Central macular thickness was measured with spectral domain optical coherence tomography (OCT)

using the three dimensional macular cube scan (Spectralis, Heidelberg engineering Inc., Ger).

Preoperative:

- Complete history taking, including personal history (age, sex, residence, systemic diseases, excluding previous eye diseases, operation or injuries).
- Visual acuity: was taken by Decimal scale. Best corrected visual acuity was detected after correction of refractive error.
- Intra ocular pressure: was detected by applanation tonometry.
- Anterior Segment examination: slit lamp biomicroscopy examination of conjunctiva, cornea, anterior chamber and lens.
- Posterior segment examination: vitreous and fundus examination by indirect ophthalmoscopy.
- OCT: central macular thickness was measured.

Postoperative:

-Visual acuity: was taken by Decimal scale at 1 & 60 days postoperatively.

-Intra ocular pressure: was detected by applanation tonometry.

-Anterior Segment examination: slit lamp biomicroscopy examination of conjunctiva, cornea, anterior chamber and intra ocular lens.

-Posterior segment examination: vitreous and fundus examination by indirect ophthalmoscopy.

-OCT: central macular thickness was measured at 1 & 60 days postoperatively. Differences in preoperative and postoperative macular thickness were analyzed.

OCT measurements:

After full pupil dilation at every visit, patients were scanned with OCT by the same OCT photographer. Both macular thickness and fast macular thickness protocols were carried out; for each protocol three scans were made, of which the best one was used in the final analysis. Six radial-line scans, 3.00mm each in length, centered on the fovea were taken. Each scan contained 100 A-scan measurements equally spaced along each line. The images obtained had a laminar structure with two bands of high intensity signal. The distance between the inner aspects of these bands was assumed to be a measure of retinal thickness. Low intensity spaces were assumed to be cystoid spaces within the retina. Central macular thickness (CMT) was computed by averaging the retinal thickness at the central points of the six scans.

Surgical technique:

All patients received Tobramicyn 0.5% drops 4 times daily from the day before surgery. Surgery was carried out after tropicamide 1% drops 4 times at 10-min intervals. Cataract surgery was performed under local anesthesia, except for two patients whose operations were carried out under general anesthesia. Standard phacoemulsification procedures were performed on patients, with a 3 mm clear corneal incision and a foldable posterior chamber IOL implantation. Eyes that experienced any intraoperative complication were excluded from the study.

Post operative treatment:

Topical Atropine 3 times daily, Tobramicyn 0.3% 6 times daily and Perednisolone acetate 1% 6 times daily.

Patients with CME:

Ketorolac tromethamine 0.5% four times daily, Diclofenac sodium 75mg tab once daily and Perednisolone acetate 1% 6 times daily.

Statistical analysis

Recorded data were analyzed using the statistical package for social sciences, version 20.0 (SPSS Inc., Chicago, Illinois, USA). Quantitative data were expressed as mean± standard deviation (SD). Qualitative data were expressed as frequency and percentage.

The following tests were done:

-**Paired sample t-test** of significance was used when comparing between related sample.

-**Probability (P-value)**:

-P-value <0.05 was considered significant.

-P-value >0.05 was considered insignificant.

3. Results

In the present study, patients age were ranged between 42 years and 72 years with the mean age was (59± 6.91 years), eyes laterality in the present study were 17 right (44.7%) and 21 left (55.3%), gender distribution was 18 males (47.3%) and 20 females (52.6%), pre-operative error of refraction were between (-13 D) and (+3 D), with the mean pre-operative error of refraction was (-3.4±3.1 D) and (15) patients had a previous history of Diabetes while (23) patients were without a previous history of diabetes.

Table (1): intraocular pressure (IOP) in the present study patients:

IOP	Min.	Max.	Mean
Pre-operative	11	17	15
Day 1 postoperative	14	18	16
Day 60 postoperative	11	15	14

In the present study, intraocular pressure (IOP) were preoperatively between (11 and 17 and the mean was 15 mmHg), the day 1 postoperatively IOP were between (14 and 18 and the mean was 16 mmHg) and

the day 60 postoperatively IOP were between (11 and 15 and the mean was 14 mmHg) as shown in table (1).

In the present study, the pre-operative BCVA ranged between (0.1) and (0.4) decimal with the mean BCVA was (0.2±0.11) decimal, post op. (day 1) BCVA ranged between (0.4) and (0.8) decimal with the mean BCVA was (0.69 ± 0.15) decimal and post operative (day 60) BCVA was ranged between (0.2-0.3) decimal in two patients (5.3 %) and in the rest of patients (94.7%) ranged between (0.4) and (0.8) decimal in (36) patient with their mean BCVA was (0.71 ± 0.18) as shown in table (2).

Table (2): mean BCVA in the present study patients:

BCVA	**Mean**
PRE OP.	(0.2±0.11) decimal
Post op day 1	(0.69 ± 0.15) decimal
Post op day 60	(0.71 ± 0.18) decimal

In the present study, mean BCVA pre operatively for all 38 eyes was (0.2±0.11) decimal and this improved to (0.69 ± 0.15) & (0.71 ± 0.18) decimal at day (1) and day (60) postoperatively this improvement in visual acuity was statistically significant at day (1) (p>0.05) and day (60) (p> 0.05) as shown in the table (3):

Table (3): Paired sample t test for preoperative and postoperative BCVA:

	BCVA		
	Mean	**SD**	**Sig.**
Difference between preoperative & day 1	-0.43	0.14	0.00
Difference between preoperative & day 60	-0.45	0.16	0.00

In the present study, pre-operative CMT of the study group ranged between (211) and (259) um with mean CMT was (248.4± 13.9) um, The post operative (day 1) CMT of the study group ranged between (228) and (277) um with the mean CMT was (249.9 ± 12.9) um and the post operative (day 60) CMT of the study group: (36) patients was ranged between (242) and (319) um with their mean was (289.8±16.2) um and in (2) patients were (370) and (451) and um as shown in fig. (1 & 2) and table (4):

Table (4): mean CMT in the present study patients:

CMT	**Mean**
PRE OP.	(248.4± 13.9) um
Post op. day 1	(249.9 ± 12.9) um
Post op. day 60	(289.8±16.2) um

Postoperative CMT was significantly thicker than those in preoperative assessment (**P>0.05**) except when comparing preoperative with day 1 post operative CMT **(P > 0.05)** as shown in the table (5):

Table (5): Paired sample t test for preoperative and postoperative CMT:

	CMT		
	Mean	**SD**	**Sig.**
Difference between preoperative & day1	-1.58	10.23	0.4
Difference between preoperative & day60	-41.39	15.55	0.000

4. Discussion

In the present study, the patients age were ranged between 42 years and 72 years with the main age was (59± 6.91 years). This result was in agreement with the results obtained by ***Gharbiya et al.,2013*** who found that the mean patients age in them study were (62.1±5.8 years).

In the present study, the patients' gender was 18 males and 20 females, (15) patients had a previous history of diabetes and (23) patients were without previous history of diabetes and the pre-operative error of refraction were between (-13 D.) and (+ 3 D.) with the mean pre-operative error of refraction was (-3.4±3.1 D.) With no statistical difference between them.

In the present study, the pre-operative BCVA ranged between (0.1) and (0.4) decimal with the mean BCVA was (0.2±0.11) decimal. Similar results also

been given by ***Cetinkaya et al.,2015*** who found that Preoperative BCVA was (0.17 ± 0.17) decimal.

The post op. (day 1) BCVA ranged between (0.4) and (0.8) decimal with the mean BCVA was (0. 69± 0.15) decimal while the post op. (day 60) BCVA was ranged between (0.2-0.3) decimal in (2) patients (5.3 %) and in the rest of patients (94.7 %) ranged between (0.4) and (0.8) decimal in (36) patient with their main BCVA was (0.71± 0.18) decimal, similar results was reported with ***Cetinkaya et al.,2015*** who found that postoperative BCVA was (0.71 ± 0.23) decimal.

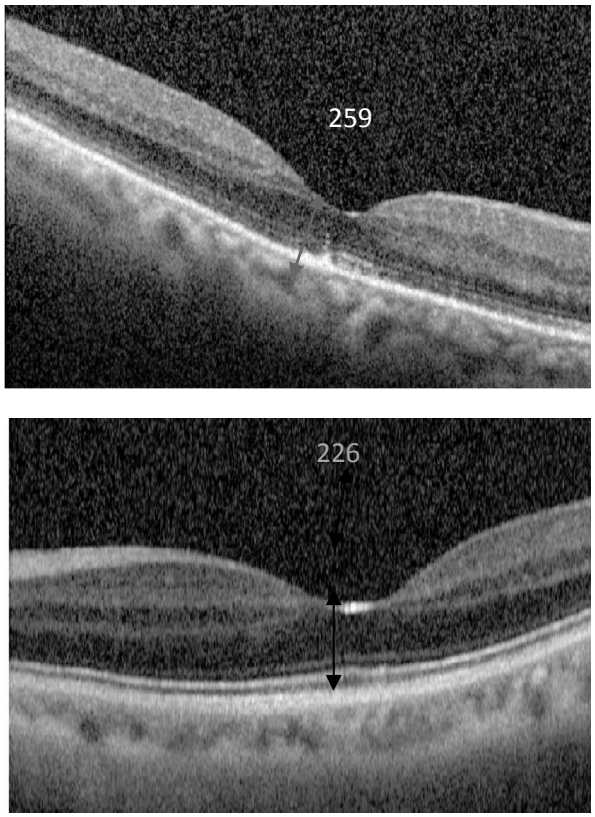
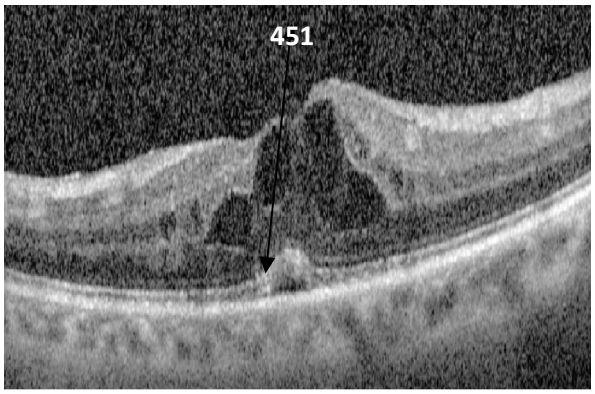


Fig.1: preoperative CMT.



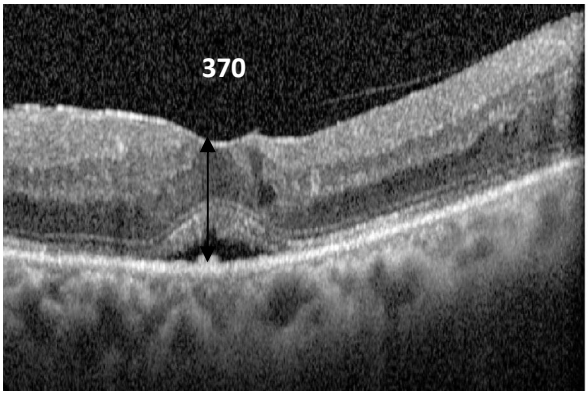


Fig.2: postoperative CMT in PCME patients.

The mean BCVA pre operatively for all 38 eyes was 0.2± 0.11 decimal and improved to (0.69± 0.15) & (0.71± 0.18) decimal at day (1) and day (60) postoperatively this improvement in visual acuity was statistically significant at day (1) ($p < 0.05$) and day (60) ($p < 0.05$) this results is in agreement with ***Şahin et al., (2013)*** who found statistically significant difference between the mean pre operative BCVA from one side and the mean post operative (day 1) BCVA and the mean post operative (day 60) BCVA from the other side.

In the present study, the pre-operative CMT of the present study group ranged between (211) and (259) um with mean CMT was (248.4± 13.9) um which match with the results obtained by ***Zhang & Dong, (2013***) who found the mean CMT was (243.7± 14.2) um.

In the present study, The post operative (day 1) CMT of the study group ranged between (228) and (277) um with the mean CMT was (249.9 ± 12.9) um while the post operative (day 60) CMT of the study group: (36) patients was ranged between (242) and (319) um with their mean CMT was (289±16.2) um and in (2) patients was (370) and (451) um.

The ratio of increase in the post operative day 60 CMT in the non CME group is less than 30 % without decrease in day 60 post operative BCVA or presence of OCT findings. ***Kim et al., (2007***) set a cut-off point of greater than 30 % of the mean preoperative central macular thickness (CMT) as an indicator of the presence of PCMO. Also ***Singh et al., (2012)*** found that the PCME obtained by OCT ≥ 30% increase in CMT relative to the presurgical baseline measurement. ***Ticly et al., (2014)*** defined the PCME by OCT as the presence of well-defined cystic fluid pockets or a CMT above 315 µm. ***Wang et al. (2013)*** defined the PCME as Impaired BCVA, macular alterations during fundus examination and CRT of > 250µm on OCT and the presence of intraretinal cystoid space beneath the fovea.

In the present study, a wide Varity of macular thickness has been detected in the pre operative assessment, such results have similarity to ***Chan et al.,* (2006)** who published that the macular thickness can vary relatively in the normal population.

Therefore, it's often difficult to define the differences between a subclinical thickening and a macular edema.

In the present study, the mean preoperative CMT of the patients was 248.4±13.9 um while the mean CMT at day 1 and day 60 post operatively were 249.9±12.9 & 289±16.2 um respectively. The postoperative CMT was significantly thicker than those in the preoperative assessment (**P<0.05**) except when comparing the preoperative with day 1 post operative CMT **(P > 0.05)** which come in accordance with ***Gharbiya et al., (2013)*** who found that there is progressive significant increase in retinal thickness of the operated eyes.

Cupo et al., (2013) suggested the concept that retinal thickening is a continuous process followed by macular edema, a small increase of macular thickness should be regarded as predictor of pathological changes. The significant increase of OCT measured foveal thickness that found in operated eyes seems to confirm the high appearance of subclinical alterations involving the macular blood retinal barrier (BRB) during the postoperative period.

Biro and Balla, (2010) compared the CMT of 18 eyes of diabetic patients with 36 eyes of nondiabetic patients using SD-OCT preoperatively and at 1, 7, 30, and 60 days post-op, with the contralateral eye acting as the control. Patients with any other ophthalmic pathologies were excluded, as well as those with severe NPDR or with proliferative DR. A significant increase was noted in the CMT in both the groups with DM and without DM as compared with their respective controls.

Lobo et al., (2004) conducted a study on 32 eyes of 32 patients who had uneventful phacoemulsification with implantation of foldable IOL. The study showed that an increase in retinal thickness reached a maximum at 6 weeks in 13 of 32 eyes after which recovery was progressive. At 30 weeks, all eyes had good visual acuity, but 7 eyes still had macular oedema.

Sood & Narang, (2009) found that in uncomplicated phaco foveal thickness and macular thickness increased after surgery and it has significant correlation with visual acuity. There is spontaneous reduction in visual acuity at 3 months as compared to 1 month and incidence of CME was 8.33%.

In the present study, post operative day 60 CMT were examined by OCT for any changes in the CMT as many literatures assumed that it is the peak of the increase in CMT. ***Gharbiya et al., (2013)*** found that from the first week after surgery the retinal thickness of the central fovea began to increase from the first month, with a peak at 2. At 6 months after surgery, retinal thickness tended to normalize in the central fovea, whereas it remained increased in outer macular area. ***Zhang & Dong, (2013)*** also found that characteristics of PCME include a long disease course and its more apparent influence on the BCVA and assumed to appear at the 4th to 6th weeks after cataract phacoemulsification.

In the present study, there was no correlation between visual acuity and post-operative macular thickness increase. Similar results were detected with ***(Gharbiya et al., 2013)*** who reported that macular thickness increase was at subclinical level with no correlation between macular thickness changes and visual acuity.

The rate of the PCME in this study was 5.3% and all of these patients had an unsatisfactory increase in visual acuity which come in accordance with ***Gharbiya et al., (2013***) who found the rate of PCMO in their study was 5 % and ***Shahin et al., (2015)*** who found that the rate of PCMO in their study was 7.5 % by OCT.

The forms detected for PCMO in the present study were: Diffuse thickening of the retina, cystoid abnormalities within the retina and distortion of the foveal contour. Similar findings were reported by ***Kim & Bressler (2009)*** who found that there is one of three recognizable patterns were detected. Frank cystoid abnormalities within the retina with distortion of the foveal contour are classic findings. Diffuse thickening of the retina with blunting of the foveal contour but no definite cystoid abnormalities can also be seen. Slight intraretinal cystoid abnormalities without substantial increase in retinal thickness or loss of foveal contour can be seen and are perhaps more common.

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