

To Evaluate the Changes in Central Macular Thickness After Uncomplicated Phacoemulsification Cataract Surgery Using Optical Coherence Tomography- A Prospective Study

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ABSTRACT

BACKGROUND

Phacoemulsification for cataract is the standard surgery in recent times with very good results and least complications. Macular area is the most important part of the retina, which is very sensitive for any type of insult on the Eye. It takes different durations for the macula to return to normal condition after phacoemulsification. We wanted to evaluate the macular thickness change occurring after uncomplicated phacoemulsification cataract surgery in post-operative period by using spectral-domain optical coherence tomography.

METHODS

In this prospective study, a total of 100 patients who underwent uncomplicated phacoemulsification cataract surgery were evaluated. Complete ophthalmological examination was done preoperatively. Patients were followed on day 7, week 4 and week 8 postoperatively. At each visit a complete ophthalmological examination was done and optical coherence tomography of macula was performed.

RESULTS

In the current study, we found a significant subclinical increase in central macular thickness at postoperative week 1, week 4 and week 8. Cystoid macular oedema was not noted in any of the patients. A statistically significant increase in foveal volume was observed on day 7, week 4 and week 8 (p value 0.001).

CONCLUSIONS

There was increase in central macular thickness and foveal volume after the uncomplicated phacoemulsification cataract surgery on day 7, week 4, and week 8 postoperatively. The increase in macular thickness was sub-clinical and did not affect final visual outcome in any patient. Further evaluation is required to trace its return to preoperative value.

KEYWORDS

Phacoemulsification, Central Macular Thickness, Optical Coherence Tomography (OCT), Cystoid Macular Oedema (CME), Central Macular Thickness (CMT), Central Foveal Thickness (CFT)

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BACKGROUND

The macular area is the most important part of the retina, which is very sensitive to any type of insult on the eye. Any insult to macular area results in structural and functional alterations which results in deterioration of visual acuity. Cystoid macular oedema following cataract surgery is one such manifestation. Phacoemulsification with foldable posterior chamber intraocular lens (PCIOL) for cataract is the standard surgery with very satisfying results and minimal complications in recent times.¹ The procedure is efficient, and uneventful surgery is generally associated with good results.^{2,3,4} It has decreased the chance of Cystoid Macular Oedema (CME). Angiographic CME may be detected in as many as 20% of uncomplicated surgeries, but is only visually significant in 2%.⁵ Recent studies have shown that optical coherence tomography (OCT) can detect clinically insignificant, macular swelling.⁶

OCT is a diagnostic tool that can perform tomography/cross sectional imaging of biological tissues with <10 microns (μ) axial resolution using light waves with the help of ~830 nm diode laser light. Since retina is easily accessible to the external light, it is especially suited for retinal disorders. This imaging technique provides information regarding the retinal tomography and is akin to in vivo histopathology of the retina. Other advantages include its ease of use, reproducibility, non-invasiveness, safety and repeatability. Though there have been studies using OCT to detect subclinical macular oedema after uncomplicated phacoemulsification, but there is no such study done in Kumaun region.

We wanted to study macular thickness changes after phacoemulsification cataract surgery in patients and correlate it with best-corrected visual acuity with central macular changes postoperatively.

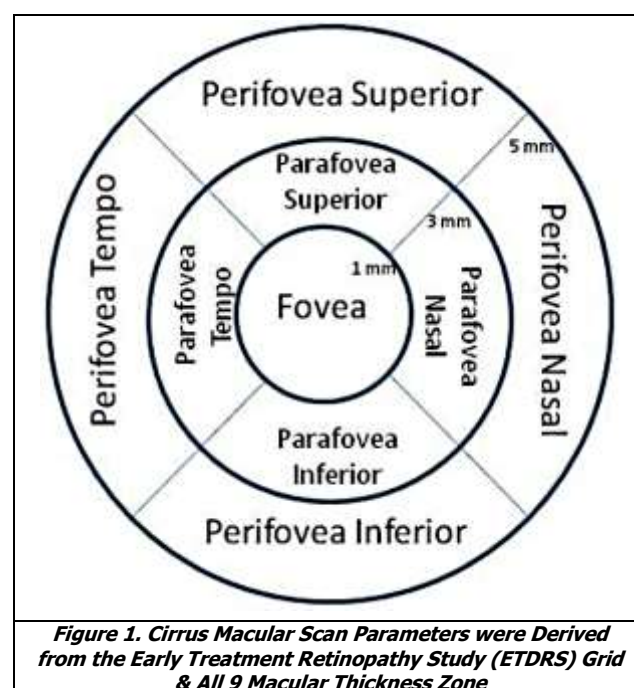
METHODS

It was a prospective follow up study conducted at Department of Ophthalmology Government Medical College Haldwani (Uttarakhand) from November 2017 to November 2019. Patients having visually significant senile cataract (Grade I-III) were included in the study (LOCS III classification). All the patients underwent phacoemulsification cataract surgery by a single surgeon. Patients having age related macular degeneration, diabetic retinopathy, glaucoma uveitis, patient with corneal or vitreous opacities, traumatic cataract, complicated cataract, amblyopia, grade IV cataract, patients with intraoperative complications like posterior capsular rupture, vitreous loss, patients with diabetes and hypertension were excluded from the study. Informed consent was obtained from all the patients.

The sample size was calculated for a significance of 0.05 and a power of 0.80 and an effect size of 0.3 with a software GPower 3.1.2 which came to be 87 patients, to account for 10% dropout in follow up, a total of 100 patient were taken

(Muhammed Sahin et al).⁷ A detailed ocular and systemic history was taken. Each patient underwent best corrected visual acuity measurement with LogMAR equivalent of standard Snellen's Chart and Snellen near vision of both eyes. All the patients underwent anterior segment examination, biomicroscopic evaluation with fundus non-contact +90 D lens.

The OCT was done to measure central macular thickness (Macular cube 512*128) was performed on all patient using a spectral domain Optical Coherence Tomography (Cirrus SD-OCT by Carl Zeiss) preoperatively and postoperatively at 1st week, 4th week, 8th week postoperatively to evaluate any macular thickness changes in all the 9 areas within 6 mm, i.e. Central foveal, Inner superior, Inner nasal, Inner inferior, Inner temporal, Outer superior, Outer nasal, Outer inferior and Outer temporal quadrants (Figure 1).



The patients underwent uncomplicated phacoemulsification cataract surgery. The study parameters which were evaluated on preoperative day were taken as baseline. A 30% increase in foveal thickness from baseline was considered as macular oedema. Postoperatively, the patients were given topical moxifloxacin 5%, topical prednisolone 1% and topical homatropine 2%. The treatment was tapered off within 1 month and the patients were called for follow up at week 1, week 4 and week 8. Best corrected visual acuity and central macular thickness were evaluated on post-operative day 7 week 4 and week 8.

Statistical Analysis

Statistical analysis was carried out using EViews 10 Student Version Lite software. The pre and the post-operative measurement were compared statistically compared using the paired t test. p-value less than 0.05 was considered to be statistically significant.

Sl. No.	OCT Measurement	Pre-Operative (Baseline)	Post-Operative Week 1	Post-Operative Week 4	Post-Operative Week 8	Statistical Significance
1.	Central foveal thickness 1mm (µm)	238.97 ± 35.44	245.71 ± 35.99	247.17 ± 36.63	250.44 ± 36.65	<.001
2.	Parafoveal Superior (3 mm) (µm)	302.75 ± 30	306.87 ± 28.05	308.89 ± 28.02	309.03 ± 29.41	<.001
3.	Parafoveal nasal (3 mm)	299.3 ± 32.21	303.13 ± 33.54	306.03 ± 32.99	305.2 ± 32.56	<.001
4.	Parafoveal inferior (3 mm)	301.26 ± 34.93	305.27 ± 35.31	308.03 ± 39.05	309.21 ± 36.16	<.001
5.	Parafoveal temporal 3 mm	300 ± 34.61	299.51 ± 36.98	303.04 ± 40.66	305.83 ± 35.61	<.001
6.	Perifoveal superior 6 mm	270.35 ± 26.72	274.09 ± 25.73	274.74 ± 26.39	277.26 ± 25.53	<.001
7.	Perifoveal nasal 6 mm	272.21 ± 29.76	279.69 ± 30.67	281.15 ± 30.54	285.31 ± 29.07	<.001
8.	Perifoveal inferior 6 mm	264.6 ± 35.17	269.63 ± 37.03	271.46 ± 38.68	274.51 ± 39.68	<.001
9.	Perifoveal temporal 6 mm	266.55 ± 27.92	268.33 ± 26.18	273.05 ± 28.36	272.34 ± 26.99	<.001
10.	Mean foveal volume (mm ³)	9.46 ± 0.68	9.61 ± 0.68	9.73 ± 0.70	9.79 ± 0.69	<.001

Data presented as mean ± SD, *Paired samples t-test.
Preoperative OCT measurement were taken as control and compared with post-operative OCT measurement at each interval

Table 1. Pair Comparison for the Day Before Cataract Surgery and Week 1, Week 4 and Week 8 After Cataract Surgery in Central Foveal and Eight Perifoveal Areas

RESULTS

This prospective study included 100 patients who underwent uncomplicated phacoemulsification surgery. Out of 100 patients there were more female (52%) as compared to male (48%) (table 1). The mean ± SD age of patients was 64.46 ± 9.04 years (age range 40-84) (Figure 2).

Gender	Number of Patients	Percent of Patients (%)
Female	52	52
Male	48	48

Table 2. Age Distribution of Patients

Preoperatively the central macular thickness (CMT) was 238.97 ± 35.44 µm, during the postoperative follow up of the patient we found the central macular thickness (CMT) values were significantly higher than the preoperative values at all intervals (at the postoperative week 1, week 4 and week 8) (P<.001). The CMT values at the post-operative week 1 was 245.71 ± 35.99 µm, at week 4 it was 247.27 ± 36.63 µm and at the week 8 the CMT was 250.44 ± 36.65 µm (table 2) (figure 3).

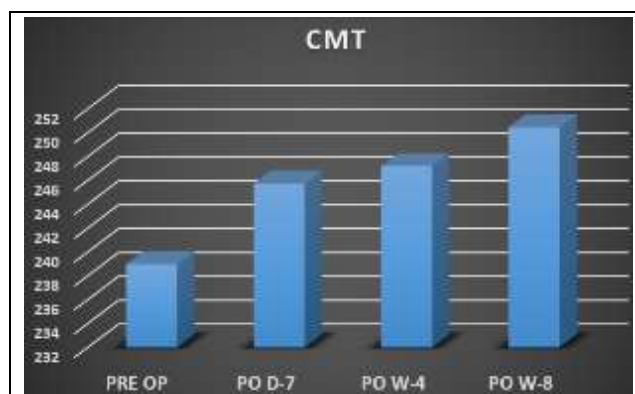


Figure 3. Central Macular Thickness at Different Time Intervals

The preoperatively inner superior thickness (parafoveal 3 mm) was 302.75 ± 30 µm, at postoperative week 1 it was 306.87 ± 28.05 µm, at week 4 it was 308.89 ± 28.02 µm. At week 8th it was 309.03 ± 29.41 µm. (Table 1). Preoperatively the inner nasal area (parafoveal 3 mm) thickness was 299.3 ± 32.21 µm, at postoperative week 1 it was 303.13 ± 33.54 µm, at postoperative week 4 was 306.03 ± 32.99 µm, postoperative week 8 it was 305.2 ± 32.56 µm (Table 1). In the present study the preoperative inner inferior (parafoveal 3 mm) thickness was 301.26 ±

34.93 µm after postoperative week 1, 305.27 ± 35.31µm at week 4 it was 308.03 ± 39.05 µm and at week 8 it was 309.21 ± 31.16 µm (Table 1). Preoperatively the inner temporal (parafoveal 3 mm) thickness was 300 ± 34.61 µm, at week 1 it was 299.51 ± 36.98 µm at week 4 it was 303.04 ± 40.66 µm and at week 8 it was 305.83 ± 35.61 µm (Table 1). Preoperatively in the outer superior (perifoveal 6 mm) the thickness was 270.35 ± 26.72 µm, at postoperative day 7 it was 274.09 ± 25.73 µm, week 4 it was 274.74 ± 26.39 µm and at post-operative week 8 it was 277.26 ± 25.53 µm. (Table 1).

In the outer nasal (perifoveal 6 mm), preoperative OCT measurement was 272.21 ± 29.76 µm at postoperative day 7 it was 279.69 ± 30.67 µm, at week 4 it was 281.15 ± 30.54 µm and at postoperative week 8 it was 285.31 ± 29.07 µm (Table 1). In the outer inferior (perifoveal 6 mm) preoperative OCT measurements was 264.6 ± 35.17 µm, at post-operative day 7 it was 269.63 ± 37.03 µm, at week 4 it was 271.46 ± 38.68 µm and at postoperative week 8 it was 274.51 ± 39.68 µm (Table 1). In the outer temporal (parafoveal 6mm) the preoperative measurement ranges from 266.55 ± 27.92 µm, at day 7 it was 268.33 ± 26.18 µm at week 4 it was 273.05 ± 28.36 µm and at week 8th it was 272.34 ± 26.99 µm (Table 1).

An increase in thickness was observed in all the 9 areas of the macula at all postoperative intervals and the increase was found to be statistically significant (p<.001). Preoperatively mean foveal volume was 9.467 ± 0.68 mm³, at week 1 it was 9.61 ± 0.68 mm³, at week 4 it was 9.73 ± 0.70 mm³ and at week 8 it was 9.79 ± 0.69 mm³. The increase was found to be significant at all postoperative intervals (p value 0.001) (Table 1).

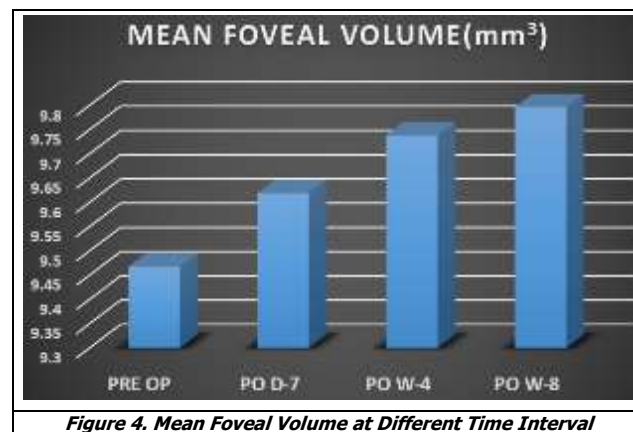


Figure 4. Mean Foveal Volume at Different Time Interval

Mean pre-operative best corrected visual acuity (BCVA) (LogMAR) was 0.74 ± 0.34 and it improved postoperatively in all follow up intervals (Table 3).

Groups	Pre-Op (LogMAR)	Post-Op Day 7 (LogMAR)	Post-Op Week 4 (LogMAR)	Post-Op Week 8 (LogMAR)
Mean \pm SD	0.74 ± 0.34	0.20 ± 0.17	0.04 ± 0.08	0.04 ± 0.08
p value		<.001	<.001	<.001

Table 3. Comparison of Preoperative and Postoperative BCVA (LogMAR)

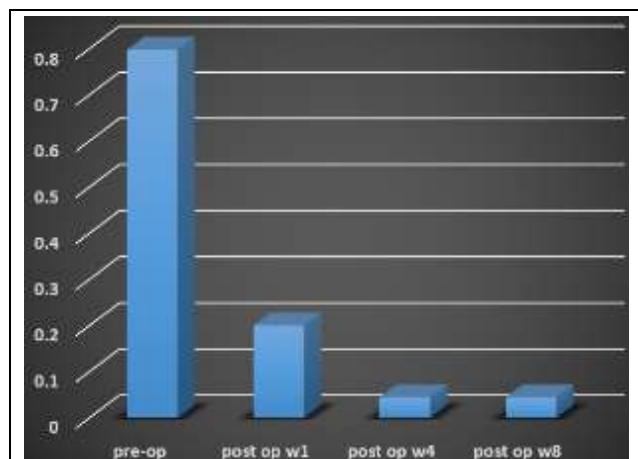


Figure 5. Comparison of Best Corrected Visual Acuity at Different Time Intervals

In the patients who underwent cataract surgery subclinical increase in macular thickness was noted without the visual acuity being affected also the cystoid macular oedema was not noted in any of the patients in the current study (Table 1).

DISCUSSION

Despite recent surgical advances in cataract surgery CME is still a common cause of decreased visual activity after cataract surgery. When the post cataract surgery macular oedema is associated with a decrease in visual acuity, it can be categorized as clinical pseudophakic cystoid macular oedema.

Macular Thickness Changes- Post-Operative Week 1

Biro et al⁹ studied changes in foveal and perifoveal thickness as determined by OCT; after phacoemulsification cataract surgery with IOL implantation. These authors noted a significant change in the macular thickness on postoperative days 1, 30, and 60, in the perifoveal 3.0 and 6.0 mm sectors, either calculated alone or averaged together with the foveal values. The initial preoperative mean value of 234.1 ± 2.6 microns (mean \pm SEM, n=536) in the 6.0 mm perifoveal region increased to 242.5 ± 2.6 microns (mean \pm SEM, n=488, p<0.05) at one week, to 247.7 ± 4.6 microns (n=352, p<0.01) at one month, and to 246.0 ± 5.9 microns (n=208, p<0.05) at two months after surgery, which proved to be significant. However, the relative change in the macular thickness, namely 3.5, 5.6, and 5.3% at the above

periods, respectively, was moderate. In our study, there was a significant increase in macular thickness as compared to the preoperative values of most of the macular parameters. The increase in week 1 was found to be significant in all the 3mm and 6mm quadrants. Preoperatively, the Central Macular Thickness (CMT) was $238.97 \pm 35.44 \mu\text{m}$. In week 1, CMT was increased to $245.71 \pm 35.99 \mu\text{m}$. This is also consistent with the finding of Biro et al,⁸ von Jagow et al⁶ and Perente et al.⁹

Macular Thickness Changes- Post-Operative Week 4-8

On week 4 a significant increase in all macular parameters was observed. This is also consistent with the finding of Biro et al,⁸ Sood et al,¹⁰ Jurecka et al,¹¹ Torren et al¹² and Perente et al.⁹ The change which appeared on day 7 gradually increased by a marked rise in week 4-8 measurement in most of the macular parameters. On week 4, CMT was found to be $247.17 \pm 36.63 \mu\text{m}$. On week 8, CMT was found to be $250.44 \pm 36.65 \mu\text{m}$. In the current study, we found a significant subclinical increase in macular thickness at postoperative week 1, week 4 and week 8. However, visual acuity was not affected.

Correlation of Surgical Parameters and Grades of Cataract with Macular Changes

Jurecka et al¹¹ noted that there was a positive statistical correlation between the real phacoemulsification time and the increase in macular volume and retinal thickness in the fovea and the inner macular area in the first week and in the first and second months following surgery). Moreover, a positive statistical correlation was found between the overall duration of the surgical procedure and the increase in the macular volume and retinal thickness in all areas one month after surgery. In the present study there was no positive correlation between the increase in the central macular thickness and the real phacoemulsification time or between the increase in the macular thickness and the overall duration of surgical procedure. Also, there was no correlation between grades of cataract and increase in macular thickness. From the above discussion, it is clear that macular thickness increases significantly post-cataract surgery. The reason for this rise in thickness is the subclinical breakdown of the blood retinal barrier as shown by several studies using fundus fluorescein angiography.¹³⁻¹⁵

Sambuddha Ghosh et al. performed a prospective randomized comparative study of macular thickness following phacoemulsification cataract surgery and that following SICS. On the first postoperative day, the central subfield mean thickness (CSMT) in the SICS group ($192.8 \pm 17.9 \mu\text{m}$) was not significantly different from that in the phacoemulsification group ($192.1 \pm 27.4 \mu\text{m}$). However, on the 7th day, the CSMT in the SICS group ($198.9 \pm 21.4 \mu\text{m}$) was significantly greater than that in the phacoemulsification group ($193.1 \pm 19.3 \mu\text{m}$). Again, on the 42nd day, the CSMT in the SICS group ($207.8 \pm 26.3 \mu\text{m}$) significantly exceeded that in the phacoemulsification group ($198.3 \pm 23 \mu\text{m}$). The increase in macular thickness was sub-clinical and did not affect final visual outcome in any patient.

Mentes et al,¹⁶ Biro et al⁸ and Sambuddha Ghosh et al did not observe clinical macular oedema in their study population. Kim et al¹⁷ reported that there seemed to be a threshold of postcataract surgery macular thickening associated with clinically impaired visual outcomes. An increase of 40% or more in macular thickness¹⁷ or a morphological Irvine Gass pattern of cystic changes as detected by OCT¹⁸ could be regarded as a threshold for reporting clinical vision-relevant post cataract macular oedema. Similarly, in the present study, cystoid macular oedema was not noted in any of the patients. This may be due to the absence of risk factors in the patients like diabetes, epinephrine infusion, increased operating time, pre-existing uveitis, absence of posterior capsule rupture, epiretinal membrane, hypertension (rarely). We thus believe that the increases in macular thickness in all of our cases could only be regarded as subclinical changes.

One of the limitations of the present study was the relatively short post-operative study duration over which patients came for review. The peak increase in central macular thickness was found in 8th week of postoperative period. However we could not trace its return to preoperative period. An important reason for this was that, in the absence of notable complications, patients felt it was not necessary to present for review. It is possible that if the follow-up period had been longer, say till 6 months the results could have been different.

CONCLUSIONS

Subclinical macular edema occurs after uncomplicated cataract surgery with the peak at 8th week after uncomplicated phacoemulsification cataract surgery. OCT is a useful non-invasive diagnostic tool in determining subclinical CME in cataract surgery patients. OCT showed macular edema without altering the architecture of macula. There is no effect of subclinical macular oedema on visual acuity.

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