

## Central macular thickness change after uneventful small-incision cataract surgery - An observational study

Garvita Dabas, Prachi Shukla, Kopal Mithal, Suman Bhartiya, Vijay Pratap Singh, Swati Agarwal

**Purpose:** The purpose of this study was to diagnose CME with the help of optical coherence tomography (OCT) after uneventful cataract surgery to prevent visual deterioration. **Methods:** This study was conducted on 120 patients, who underwent manual small-incision cataract surgery with posterior chamber intra-ocular lens implantation. Follow-up was performed after the first week, sixth week, and 12<sup>th</sup> week post-operatively. Detailed examination was performed at each visit along with measurements of central macular thickness using OCT. Statistical analysis was performed using SPSS 22.0. **Result:** The mean age of the patients was  $61.85 \pm 11.41$  years having female preponderance. The pre-operative mean best corrected visual acuity (BCVA) was found to be  $0.05 \pm 0.04$ , whereas the mean post-operative BCVA was found to be  $0.65 \pm 0.17$  at the first week,  $0.66 \pm 0.17$  at the sixth week, and  $0.67 \pm 0.17$  at the 12<sup>th</sup> week follow-up. The post-operative mean macular thicknesses at the first week, sixth week, and 12<sup>th</sup> week post-operatively were documented to be  $221.66 \pm 8.49 \mu\text{m}$ ,  $224.60 \pm 8.75 \mu\text{m}$ , and  $219.17 \pm 8.22 \mu\text{m}$ , respectively. **Conclusion:** A sub-clinical increase in macular thickness occurs even after uncomplicated cataract surgery. The maximum increase was observed after 6 weeks of surgery, which returns to near normal values within 3 months. Comparison of central macular thicknesses pre-operatively and post-operatively at the first week, sixth week, and 12<sup>th</sup> week suggests a significant correlation.

**Key words:** Cystoid macular edema, pseudophakic, SICS

Cataract is globally a primary cause of preventable blindness. Cataract surgery is the most common surgery performed in the field of ophthalmology. Small-incision cataract surgery (SICS) and phaco-emulsification are most commonly performed cataract surgeries. Cystoid macular edema (CME) is one of the late complications that may lead to vision deterioration after any intra-ocular surgery if precautions are not taken adequately to avoid, diagnose, or treat it.<sup>[1]</sup>

SICS with implantation of an intra-ocular lens has been the preferred technique among cataract surgeons, especially beginners. SICS is precise, effective, and less time-consuming without maintenance demand of equipment.<sup>[2]</sup> Also, it has been proven to be safe and effective in all types and grades of cataract. It has been observed that SICS gives lesser post-operative astigmatism, better post-operative visual outcome, comfort, and faster rehabilitation than the conventional ECCE technique.<sup>[3]</sup> We can minimize the cylindrical error if we consider the keratometric values of cornea and induced astigmatism during the SICS; it can give nearly the similar outcome as that of phaco-emulsification.<sup>[4]</sup> However, some degree of macular damage, clinically demonstrable as macular edema, continues to occur even after uneventful cataract surgery.

The overall incidence of clinical CME after uneventful cataract surgery was 1.5%. Following SICS, the incidence of clinical CME was 2%, and that after phaco-emulsification was

1%.<sup>[5]</sup> Macular edema (ME) is defined as an abnormal increase of fluid volume in the macula. The anatomical process involves intra-cytoplasmic swelling of glial cells leading to cell swelling. Gradually, the fluid starts accumulating in inter-cellular spaces, invading retinal layers and leading to the formation of "cysts".<sup>[6]</sup>

CME usually appears within 1–3 months after cataract surgery as either reduced visual acuity or changes on fluorescein angiography or optical coherence tomography (OCT). Most patients recover spontaneously, with full restoration of visual acuity within 6 months; however, it may take up to 1–2 years for complete resolution.<sup>[7]</sup>

Pseudophakic cystoid macular edema (PCME) (Irvine–Gass syndrome)<sup>[8]</sup> is a complication of cataract removal or other intra-ocular procedures. It is believed to be caused because of the release of pro-inflammatory mediators after surgical trauma, leading to the alteration of blood-ocular barrier.<sup>[9]</sup> Surgical trauma leads to release of prostaglandins, which causes a break in the blood-aqueous barrier,<sup>[10]</sup> with the resultant release of toxins and immune complexes. Prostaglandins pass through the vitreous into the posterior segment and result in outpouring of the serous fluid into Henle's layer. Increased levels of prostaglandin E (PGE) and prostaglandin F<sub>2</sub> (PGF<sub>2</sub>)

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have been demonstrated in patients with CME undergoing vitrectomy. The primary cause of CME is the leakage of fluid that is low in lipid and protein content from the peri-foveal capillaries into the extra-cellular spaces because of breakdown of the blood-retinal barrier.<sup>[11]</sup>

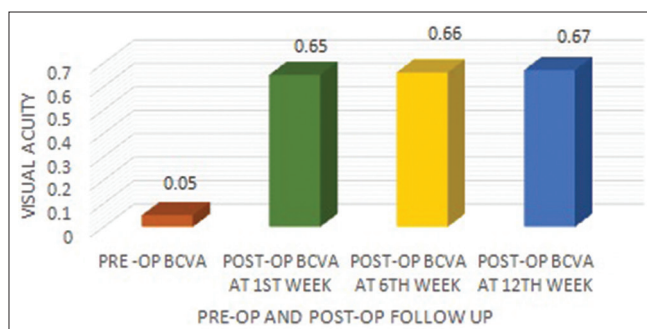
Out of all the patients undergoing uncomplicated cataract extraction, only 20% develop angiographically proven CME.<sup>[12]</sup> However, a clinically significant reduction in visual acuity is observed in about 1% of these eyes.<sup>[13]</sup> If complications occur during cataract extraction, such as posterior capsule rupture, vitreous loss, severe iris trauma, or vitreous traction at the wound, there is a significant increase in the incidence (up to 20%) of clinically apparent CME.<sup>[14]</sup> PCME can be defined as angiographical (seen on fluorescein angiography) or clinical (associated with decreased visual acuity) and is labeled as acute (within 6 months) or chronic (over 6 months).<sup>[15]</sup>

Macular edema can also be found in cases of diabetic retinopathy, age-related macular degeneration, venous occlusion, hypertensive retinopathy, central serous chorio-retinopathy, Irvin–Gass syndrome, pars planitis, uveitis and iridocyclitis, choroiditis, and retinitis pigmentosa.<sup>[16]</sup>

Macular edema (ME) can be assessed by a number of methods. Traditional methods include contact and non-contact slit lamp biomicroscopy using 60D/78D/90D, indirect ophthalmoscopy, fundus fluorescein angiography, and fundus stereo-photography. OCT has become an important tool in diagnosing and managing retinal disorders such as CME.<sup>[17]</sup> The aims and objectives of this research were to measure the incidence of CME after manual SICS using OCT. This study was conducted to diagnose and timely cure the CME in post-cataract surgery patients to prevent visual deterioration.

## Methods

This prospective, hospital-based observational study was conducted on 120 patients attending the ophthalmology out-patient department of our hospital with a clinical diagnosis of cataract and willing for cataract surgery. The study was approved by the Ethical Committee of our college (Ref. No. MMC/IEC/2020/71). Informed and written consent was taken from all the participants. All patients underwent SICS with posterior chamber intra-ocular lens implantation. Any grade of cataract allowing OCT to measure central macular thickness and patients who underwent uneventful SICS with posterior chamber intra-ocular lens implantation were included in the study.



**Figure 1:** Comparison of best-corrected pre- and post-operative visual acuity. Mean visual acuity at different durations

Patients having traumatic cataract, complicated cataract, any complication during surgery, any retinal or posterior segment pathology, glaucoma, uveitis, previous history of intra-ocular surgery in the same eye, and uncontrolled hypertension/diabetes were excluded from the study.

Follow-up was performed after the first week, sixth week, and 12<sup>th</sup> week post-operatively. Visual acuity, slit lamp examination, fundus evaluation, and intra-ocular pressure were recorded at each visit along with measurements of central macular thickness with OCT (macula line). Findings were statistically analyzed using SPSS22.0. Data comparisons were made by using paired t-test.

## Results

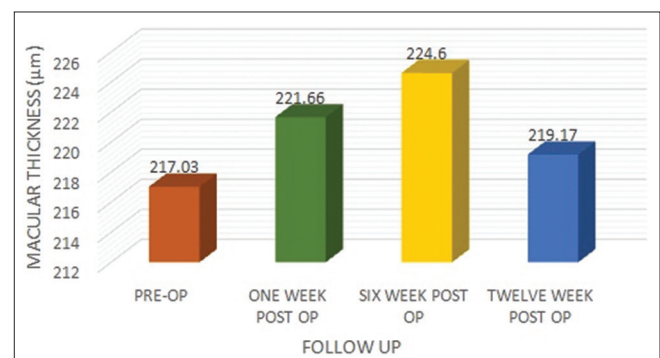
The age of the patients ranged between 40 and 98 years with the mean age being  $61.85 \pm 11.41$  years having 59.17% females and 40.83% males. Right eyes were operated in 62 patients (51.67%), and left eyes were operated in 58 patients (48.33%).

The mean surgical time was  $10.50 \pm 1.67$  minutes. Pre-operative and post-operative best corrected visual acuities (BCVAs) were recorded by Snellen's chart and converted into decimal values. Pre-operative, PL-positive patients were taken as 0. The pre-operative mean BCVA was found to be  $0.05 \pm 0.04$ , whereas the post-operative mean BCVA was found to be  $0.65 \pm 0.17$  at the first week,  $0.66 \pm 0.17$  at the sixth week,  $0.67 \pm 0.17$  at the 12<sup>th</sup> week follow-up [Fig. 1].

The pre-operative and post-operative mean macular thicknesses at different follow-up are mentioned in the graph [Fig. 2] in the operated eyes of patients who underwent cataract surgery.

The pre-operative mean macular thickness was compared with the mean macular thickness at 1 week, 6 weeks, and 12 weeks post-operative follow-up using paired t-test and was found to be a statistically significant *P* value ( $<0.00001$ ). The maximum macular edema was observed at the sixth week review, and the minimum was found at 12 weeks follow-up [Table 1].

Statistical analysis of the differences between mean pre-operative and mean post-operative values of macular thickness at different follow-up was found to be statistically significant (*p* value =  $<0.00001$ ) [Tables 2 and 3]. CME was not noted in any of the patients during any of the follow-up in the current study.



**Figure 2:** Mean macular thickness at different durations

**Table 1: Comparison between pre-operative and 1 week, 6 week, and 12 week post-operative macular thicknesses**

	Paired Differences				T	Df	Significance		
	Mean Difference	Std. Deviation	Std. Error of the Mean	95% Confidence Interval of the Difference			One-Sided p	Two-Sided p	
				Lower					Upper
Pre-operative - 1-week post-operative macular thickness	-4.63	2.72534	0.248	-5.12	-4.14	18.624	119	<0.001	<0.001
Pre-operative - 6 weeks post-operative macular thickness	-7.175	3.518	0.321	-7.81	-6.53	22.338	119	<0.001	<0.001
Pre-operative - 12 weeks post-operative macular thickness	-2.14	1.46	0.134	-2.40	-1.87	15.977	119	<0.001	<0.001

**Table 2: Comparison between 1 week post-operative and sixth and 12<sup>th</sup> week post-operative macular thicknesses**

	Paired Differences				T	df	Significance		
	Mean Difference	Std. Deviation	Std. Error of the Mean	95% Confidence Interval of the Difference			One-Sided p	Two-Sided p	
				Lower					Upper
One-week post-operative macular thickness - 6-week post-operative macular thickness	-2.54	1.65	0.151	-2.84	-2.24	16.776	119	<0.001	<0.001
One week post-operative and 12 <sup>th</sup> week post-operative macular thickness	2.491	2.45975	0.22454	2.04705	2.9628	11.097	119	<0.001	<0.001

**Table 3: Comparison between pre-operative and 1 week, 6 week, and 12 week post-operative macular thicknesses**

Macular Thickness ( $\mu\text{m}$ )	t	P
Pre-operative and post-operative 1 week	18.624	<0.00001
Pre-operative and post-operative 6 weeks	22.338	<0.00001
Pre-operative and post-operative 12 weeks	15.977	<0.00001

## Discussion

Following cataract surgery, sub-clinical changes may occur in macular thickness with or without the visual acuity being affected. However, PCME is a known complication of cataract surgery, manifesting as effusion of the fluid from the capillaries. Although this phenomenon is most often self-limiting, culminating in spontaneous resolution, it occasionally leads to marked impairment of central vision, which may become chronic or permanent. In this study, an attempt was made to determine alterations in BCVA and macular thickness in patients undergoing SICSs.

The World Health Organization estimates that the current global prevalence of preventable blindness in the world population is 1 billion, with the majority of all blindness occurring in individuals aged 50 and older, predominantly because of cataract (94 million).<sup>[18]</sup>

The age of the patients ranged from 40 to 98 years with the mean age being  $61.85 \pm 11.41$  years in this study. It was observed that 36.67% of patients were in the age group of 60–70 years, followed by 27.5% in the age group of 50–60 years (which was similar to the studies conducted by Dr. Vimal J. Vyas *et al.*<sup>[19]</sup> and

Dr Shreya Bhargava *et al.*)<sup>[20]</sup> A different age distribution was noted with the study conducted by Dr. Abhishek Salwan *et al.*<sup>[21]</sup>

The majority of the enrolled patients were females, that is, 59.17%, versus males contributing 40.83%. Right eyes were operated in 62 patients (51.67%), and the left eyes were operated in 58 patients (48.33%).

The mean surgical time was found to be  $10.50 \pm 1.66$  minutes, which was comparable to that of the study conducted by Dr. Shaik Nasreen *et al.*,<sup>[22]</sup> quoting a mean surgical time of  $9.8 \pm 0.50$  (9.5 to 10.2) minutes.

The post-operative mean BCVA was found to be  $0.65 \pm 0.17$  at the first week,  $0.66 \pm 0.17$  at the sixth week, and  $0.67 \pm 0.17$  at the 12<sup>th</sup> week follow-up.

In the study conducted by Jagow B *et al.*,<sup>[23]</sup> Cagini *et al.*,<sup>[24]</sup> Sandeep K *et al.*,<sup>[25]</sup> and Nasreen *et al.*,<sup>[22]</sup> there was no correlation found between macular thickening and visual acuity.

In 120 patients who underwent cataract surgery in our study, the pre-operative macular thickness noted was  $217 \pm 7.97 \mu\text{m}$ , but Salwan A *et al.*<sup>[21]</sup> and Bhargava *et al.*<sup>[20]</sup> documented pre-operative macular thicknesses of  $223.38 \pm 12.61 \mu\text{m}$  and  $230.49 \pm 14.42 \mu\text{m}$ , respectively, in their studies. The study performed by Sharma S<sup>[26]</sup> reported that the mean macular thickness was  $189.34 \mu\text{m}$ , which was quite less as compared to our study.

In our study, the post-operative mean macular thickness at the first week, sixth week, and 12<sup>th</sup> week was documented to be  $221.66 \pm 8.49 \mu\text{m}$ ,  $224.60 \pm 8.75 \mu\text{m}$ , and  $219.17 \pm 8.22 \mu\text{m}$ , respectively [Figs. 3-5]. A study conducted by Salwan A *et al.*<sup>[21]</sup>

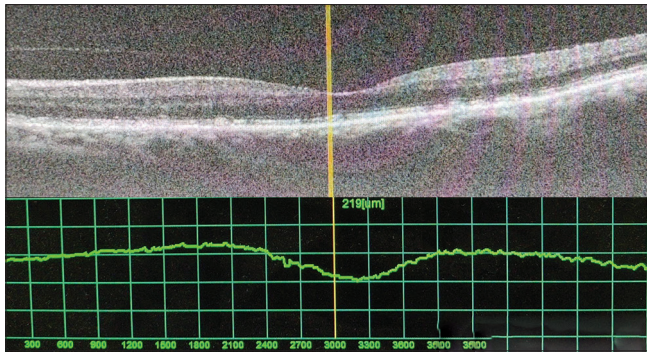


Figure 3: Pre-operative central macular thickness

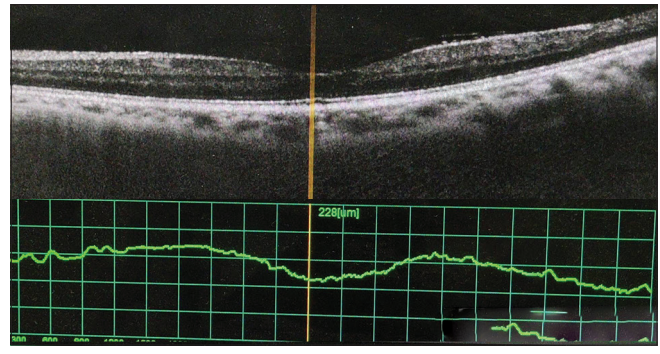


Figure 4: Central macular thickness at 6 weeks

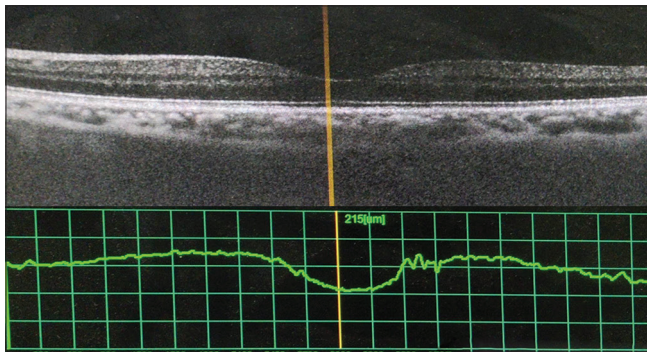


Figure 5: Central macular thickness at 12 weeks

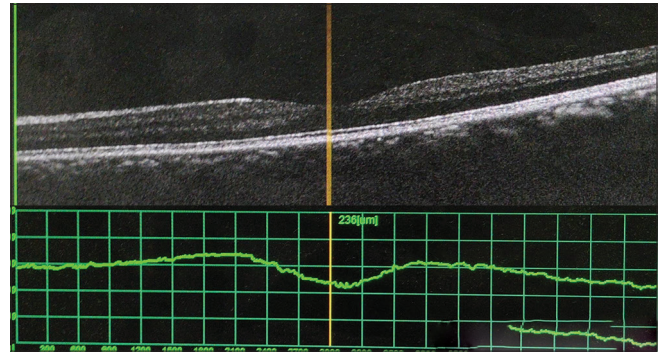


Figure 6: Increased central macular thickness in a patient with increased mean surgical duration

found the mean macular thickness at 1 week post-operatively to be  $238.28 \pm 12.29 \mu\text{m}$  and that at the 12<sup>th</sup> week post-operatively to be  $227.04 \pm 12.58 \mu\text{m}$ , which was slightly higher as compared to ours.

The study performed by Bhargava *et al.*<sup>[20]</sup> also documented that the mean macular thickness at post-operative 1 week to be  $235.43 \pm 14.87 \mu\text{m}$ , that at post-operative 6 weeks to be  $239.1 \pm 14.86 \mu\text{m}$ , and that at post-operative 12 weeks to be  $233.31 \pm 15.97 \mu\text{m}$ , which was corroborating with the findings of Salwan A *et al.*<sup>[21]</sup> The differences between pre-operative and post-operative macular thicknesses in the studies conducted by Salwan A *et al.*<sup>[21]</sup> and Bhargava *et al.*<sup>[20]</sup> were nearly similar to our findings.

A total of three patients had a floppy iris, and two had excessive bleed during surgery because of HCV positivity, which extended the operation time. The mean surgical time in these patients was 16.8 minutes [Fig. 6]. The mean macular thickness was found to be higher in these cases as compared to the other patients, that is,  $231.4 \mu\text{m}$  at the first week,  $237.8 \mu\text{m}$  at the sixth week, and  $221 \mu\text{m}$  at the 12<sup>th</sup> week. These above-mentioned patients were excluded from this study as they were not fulfilling the inclusion criteria, that is, uneventful surgery. Ramakrishnan *et al.*<sup>[27]</sup> studied the correlation between the duration of surgery and the increase in macular thickness and confirmed our observation that the patients who had a longer duration of surgery showed an increased central macular thickness.

## Conclusion

Comparisons between pre-operative central macular thickness and post-operative central macular thickness after 1 week,

6 weeks, and 12 weeks suggest a significant correlation. A sub-clinical increase in macular thickness occurs after uncomplicated cataract surgery having a peak by 6 weeks after surgery, which returns to the near normal value by 12<sup>th</sup> week post-operatively. OCT showed an increase in macular thickness without altering the architecture of the macula. There was no correlation established between the BCVA and macular edema post-operatively. A positive correlation was observed between surgical time and an increase in central macular thickness in our study.

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## Conflicts of interest

There are no conflicts of interest.

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