Study of Central Macular Thickness before and after Cataract Surgery

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Abstract

Background

The common forms of cataract surgery are phacoemulsification and manual small Incision surgery (MSICS). Increase in central macular thickness (CMT) has been reported to develop even after uncomplicated cataract surgery with best corrected visual acuity (BCVA) 20/20. Monitoring CMT may help us to detect it early and start the early treatment so that the patient can have the best vision after cataract surgery.

Methodology: This prospective observational study was carried out at a tertiary hospital in Puducherry after getting approval from the institutional research and ethics committee. All patients undergoing standard phacoemulsification and MSICS were enrolled in the study after taking written and informed consent, following strict inclusion and exclusion criteria. Preoperative CMT measurement was performed using spectral domain - Optical coherence tomography (SD-OCT). Postoperatively CMT was measured at 1 week, 3rd week, and 6th week of follow-up.

Results: Eighty-seven participants underwent phacoemulsification and 63 underwent MSICS. The majority of the participants were in the 51-60 years age group. The mean preoperative CMT was 217.3 ± 19.1 µm in the phacoemulsification group which reached 236.1 ± 16.3 µm in 6th week. The change in CMT in the phacoemulsification group was statistically significant $p<0.05$. In the MSICS group the mean CMT increased from 224.7 ± 21.8 µm pre-operatively to 254.6 ± 21.4 by the 6th week which was statistically significant.

Conclusions: Uncomplicated cataract surgery can result in a significant increase in CMT post-operatively. MSICS causes a slightly higher increase in CMT compared to phacoemulsification.

***Keywords*:** Optical coherence tomography, Small incision cataract surgery, Phacoemulsification, Cystoid macular edema

Introduction

Globally, cataracts are the most common cause of blindness.[1] Cataracts are responsible for 66.2% of total blindness in India.[2] The common forms of cataract surgery are phacoemulsification and manual small incision surgery (MSICS). Phacoemulsification has become the preferred surgical technique worldwide.[3] MSICS is still preferred in developing countries like India.[3] Some patients develop unfavorable visual outcomes following cataract surgery. The chief reason is the development of cystoid macular oedema (CME)[4]

The cataract surgery causes an inflammation in the eye. Macular thickening post cataract surgery may be induced by a number of events, including the release of prostaglandins and vascular endothelial growth factor, the disruption of the blood-retinal and blood-aqueous barriers, and surgically damaged tissue caused by postoperative inflammation.[5]

Increased central macular thickness (CMT) is seen usually seen after a complicated cataract extraction. However, increased CMT is also reported to develop even after uncomplicated cataract surgery with best corrected visual acuity (BCVA) 20/20.[6] Such cases may be missed if optical coherence tomography (OCT) is not done and may develop poor visual

outcomes in the long run. The incidence of CME rises to 10 to 20 percent when evaluated using OCT.[7] Monitoring CMT may help us to detect it early and start the early treatment so that the patient can have the best vision after cataract surgery. With this background, the study has been done with the following objectives.

Objectives

To study central macular thickness in patients with senile cataract undergoing uncomplicated cataract Surgery with intraocular lens implantation.

Materials and methods

Study Setting: This study was conducted in the Department of Ophthalmology of Sri Manakula Vinayagar Medical College and Hospital, Madagadipet, Puducherry.

Study Design: Prospective observational hospital-based study

Study Participants: Patients undergoing cataract surgery in the Department of Ophthalmology at Sri Manakula Vinayagar Medical College. Inclusion Criteria include patients age between 50 to 70years, with cataract ranging from grade I to grade III [as classified by the Lens Opacities Classification System (LOCS) III] and patients undergoing routine cataract surgery without any complications, and who were willing to undergo a follow-up for 3 months. Exclusion Criteria include any deviation in the operative steps other than standard, intraoperative complicated cases, postoperative trauma, postoperative infection, failure to follow up, patients with glaucomatous or ocular pathology and hazy media precluding pre-op OCT, and with diabetic and Hypertensive retinopathy, and Pre-existing macular diseases.

Study Duration: The data collection was done for a period of 18 months from November 2022 to May 2024

Sample Size: Considering the 53% prevalence of senile cataracts in South India found in a study by Vashist P et al, the sample size for the present study was calculated to be 150 at a 95%confidence interval and 8% absolute precision using an Open Epi Version 3, open-source calculator[8]

Sampling Technique: Consecutive sampling technique done.

Methodology

This prospective observational study was carried out in a tertiary care medical college and hospital under the Department of Ophthalmology after the approval of the ethics and research committee (EC/86/2022). After obtaining valid written and informed consent, patients were enrolled in the study. Demographic details of the participants were collected regarding name, age, gender, residence, occupation, and socioeconomic status. Detailed history related to ocular and systemic comorbid conditions was taken. Gross systemic examination and thorough ocular examination were done which included, visual acuity using Snellen's chart for distant vision which was converted into LogMAR value, and anterior segment examination was performed using a slit lamp biomicroscope. Intraocular pressure was measured by an applanation tonometer. Fundus examination was done by slit lamp biomicroscopic examination with a 90 D lens. A scan and K-reading was done.

Preoperative CMT was performed using a Topcon 3D OCT -1 Maestro 2 OCT machine following pupillary dilatation. The 3D retinal topography is a fast macular scan protocol that measures the macular thickness. The patient was positioned in a sitting position with their head stabilized on the chin and forehead rest while each eye was scanned. To map the center of the fovea, the patient was instructed to fix at the internal fixation target. The average thickness at the center of the macula in an area of 1 mm-diameter area known as CMT was measured. All scans with good centration and a signal intensity of seven or above were included. All patients underwent standard cataract surgery MSICS or Phacoemulsification. Postoperatively antibiotic-steroid eye drops were given and CMT and CCT were measured at 1 week, 3rd week, and 6th week of follow-up.

Statistical analysis:

Data obtained was entered in the software Epi info version 7.2.1.0 and was analyzed using SPSS software version 24.0. Description of categorical variables like age, gender, and occupation were mentioned in percentages and visual acuity findings were summarized in percentages. The data was analyzed by repeated measures of Anova's test. A probability value (p-value) of <0.05 was considered significant.

Results:

We had 150 participants (150 eyes) who underwent uncomplicated cataract surgery. Eighty-seven (58%) participants underwent phacoemulsification and 63(42%) underwent MSICS. The majority of the participants 88(58.6%) were in the 51-60 years age group. The gender distribution had a slightly higher number of female participants 82(54.7%) compared to male participants 68(45.3%). A significant proportion of the participants 95(63.3%) were from a low socioeconomic status, while the remaining 55(36.7%) were from a middle socioeconomic status [Table 1].

Table 1: Demographic details of the study participants N=150

S.no	Variable	Category	No of Participants (N%)
1	Age	51-60	88(58.6)
		61-70	57(38)
		>70	5(3.3)
2	Gender	Male	68(45.3)
		Female	82(54.7)
3	Occupation	Working	75(50)
		Not working	75(50)
4	Socioeconomic status	Middle	55(36.7)
		Low	95(63.3)

Eleven (7.3%) participants had Diabetes mellitus, while 23(15.3%) had Systemic Hypertension respectively. Seventeen (11.3%) of the participants were smokers, and 2(1.3%) reported to drug intake [Figure 1]

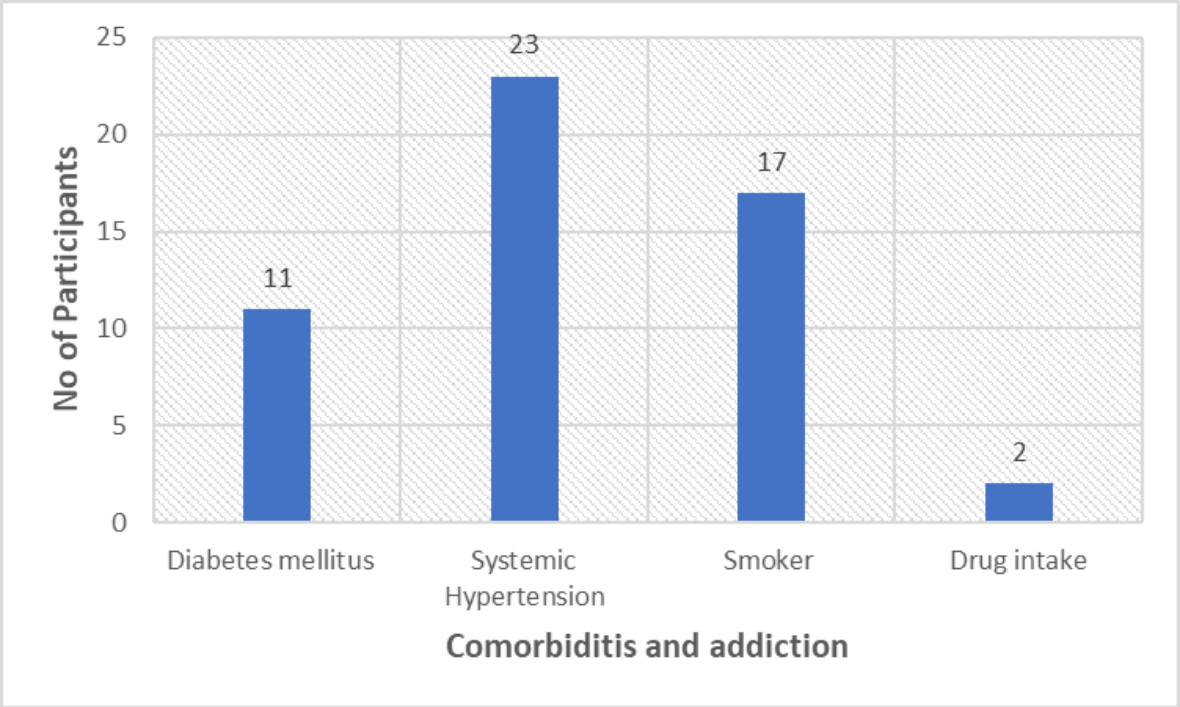

Figure 1: Bar Chart representing systemic illness and addiction status among study participants

The mean preoperative CMT was 217.3 ± 19.1 µm in the phacoemulsification group which reached 236.1 ± 16.3 µm in 6th week. The change in CMT was statistically significant $p<0.005$. For the MSICS group, the mean pre-operative CMT was 224.7 ± 21.8 µm which increased till 3rd week and then started decreasing. There was a significant change in CMT postoperatively in the MSICS group with $p<0.005$ [Figure 2]

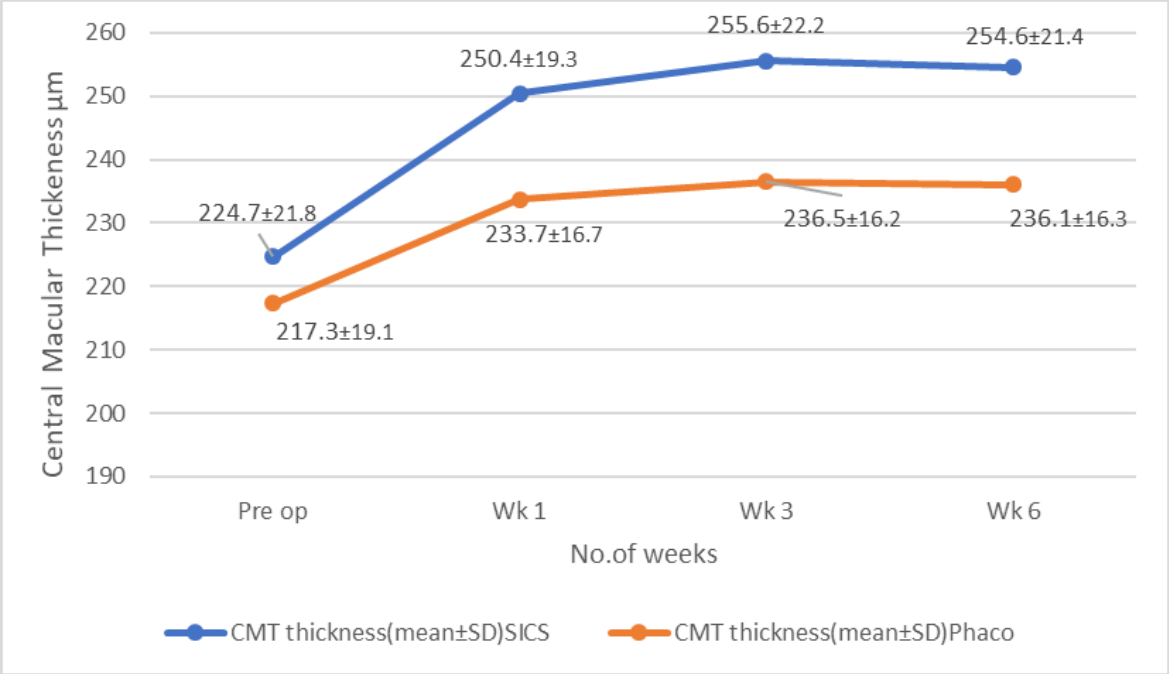

Figure 2: Line diagram showing the change in Central Macular Thickness (CMT) preoperatively and postoperatively among phacoemulsification and MSICS

There was no statistically significant difference in the preoperative CMT among the different age groups.

Age groups 51-60 years and 61-70 years both showed highly significant increases in CMT from preoperative values to each postoperative time point, with p-values of 0.00 [Table 2].

Table 2: Association of age groups with central macular thickness (CMT)

Age in years	Preoperative CMT in µm	Postoperative CMT in µm			p value
		1st Week	3rd Week	6th Week	
51-60	219.3 ± 20.4	239.1 ± 19	243.1 ± 20.5	242.1 ± 20.1	0.00
61-70	221.8 ± 22	242.8 ± 20.2	246.6 ± 22.3	246.2 ± 22.3	0.00
>70	220 ± 22.8	235.8 ± 10.9	240.4 ± 14.7	244.2 ± 15.2	0.03

There was no statistically significant difference in CMT preoperatively for both male and female patients with p-values of 0.33. There were significant_increases in CMT postoperatively for both male and female patients, with p-values of 0.00.[Table 3]

Table 3: Association of Gender with central macular thickness (CMT)

Gender	Preoperative CMT in µm	Postoperative CMT in µm			p value
		1st Week	3rd Week	6th Week	
Male	218.5±	24	24	242.	0.00

	19.2	0.5 ± 17.5	3.4 ± 18.9	5 ± 18.5	
Female	221.8± 21.6	240.6 ± 21.2	245.1 ± 22.8	244.7 ± 22.3	0.00

Discussion

We found a statistically significant increase in postoperative CMT in both phacoemulsification and MSICS groups from the pre-operative values up to the 6th-week follow-up (p-value= 0.00). In the current study, the mean preoperative CMT was 217.3 ± 19.1 µm in the phacoemulsification group which reached 236.1 ± 16.3 µm in 6th week. The change in CMT was statistically significant p=0.00 [Figure 2]. In the MSICS group the mean CMT increased from 224.7± 21.8 µm pre-operatively to 250.4 ± 19.3 µm by the 6th week [Figure 2]. A similar study done by NJ Paraskar et al noticed that there was an increase in CMT postoperatively at the first week, one month, and six months and it was found to be statistically significant in both MSICS and phacoemulsification.[9] Another study done by Parajuli S et al noticed an increase in CMT on the first day postoperatively, first week, and six weeks postoperatively when compared with preoperative CMT values following MSICS.[10] In our study also we noticed that there was an increase in CMT in the first week, third week, and sixth week postoperatively when compared with preoperative values in both MSICS and phacoemulsification surgeries.

Increase in CMT post cataract surgery was first noticed at varying periods after surgery by different studies. Similar to the present study most studies noticed an increase in CMT at the first week after cataract surgery. [10,11] Few other studies noticed a post-operative increase of CMT at the first day post-operatively. [6,13] Some studies noticed an increase in CMT after one month. [7,12,13] Parajuli S et al noticed a peak of CMT at the first postoperative week which started decreasing by the sixth postoperative week in phacoemulsification.[10]

Sharma S and Ramakrishnan R noticed the highest increase in CMT on the forty-fifth day postoperatively in both phacoemulsification and MSICS. [12,14] Biro et, al Sood et al, noticed a maximum increase in CMT in the eighth postoperative week. [13,15] A study done by Gharbiya M et al noted increase in CMT one month postoperatively after phacoemulsification.[16] In our study in the phacoemulsification group the CMT increased till the sixth week postoperatively. As our last follow-up was in the sixth week, we could not comment on the peak in the phacoemulsification group. In the MSICS group, CMT reached a peak in the third week of the current study [Figure 2]. Most studies saw complete resolution of CMT at three months postoperative period. [11,17] Few other studies complete resolution of CMT was seen at six months. [9,12] Parajuli S et al noticed that increase in CMT after MSICS which persisted even at six weeks which was their last follow-up.[10] In our study MSICS group CMT started decreasing after the third week and in the sixth week it reduced to 254.6 ± 21.4µm. In the Phacoemulsification group, it increased till the sixth week which was the last follow-up, and hence complete resolution is not known for them [Figure 2]. Sharma S and Ramakrishnan R noticed an increase in CMT was more in MSICS than phacoemulsification. [12,14] We too noticed that there was a significantly higher increase in CMT among MSICS compared to Phacoemulsification (p value=0.00). MSICS can induce more inflammation because of larger incisions and greater chances of insult to the iris. Phacoemulsification, being a closed chamber surgery, causes lesser inflammation when done well. Hence MSICS is likely to cause more increase in CMT compared to phacoemulsification.

In the current study, postoperatively there was no significant difference in CMT between different age groups (p value=0.74), but all age groups showed a significant increase in CMT postoperatively [Table 2]. This can be explained by the fact that preoperatively also there was no significant

difference in CMT between different age groups (p value=0.9).

Both males and females had a significant increase in CMT postoperatively (p=0.00) in our study, but there was no significant difference in CMT postoperatively between males and females (p value=0.52) [Table 3]. This possibility can be supported, as preoperatively also there was no significant difference in macular thickness between males and females (p value=0.33).

The cataract surgery initiates an inflammation in the eye. Pathogenic mechanisms of macular thickening post-cataract surgery may be induced by several events, including the release of prostaglandins and vascular endothelial growth factor, the disruption of the blood-retinal and blood-aqueous barriers, and postoperative inflammation caused by surgically damaged tissue.[5] Subclinical changes can occur in macular thickness after cataract surgery which is often self-limiting. The anatomical process involves intra-cytoplasmic swelling of glial cells which causes cell swelling and increases macular thickness.[18] If the inflammation is not treated at the appropriate time, gradually, the fluid starts accumulating in inter-cellular spaces, invading retinal layers and leading to the formation of cysts.[18] CME may appear within 1–3 months after cataract surgery as either reduced visual acuity or changes on FFA or OCT. [6] 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.

Another retrospective study done by Iftikha M et al on the incidence of CME after phacoemulsification noticed that patients with pre-existing diabetic retinopathy are more likely to develop CME and have poor visual outcomes.[19] Our study though CMT was increased in all participants postoperatively, but none of them had cystic changes at 6 weeks. We included the patients with controlled DM without diabetic retinopathy.

Two patients reported to us after two months with a decrease in visual acuity and showed CME on OCT. They were treated with NSAIDS eye drops. A study done by ML Nelson et al noticed vision loss from CME is temporary and responds to NSAIDS.[20]

In this study, all surgeries were done by a single surgeon. We documented macular edema using SD-OCT and included only participants with scans of signal strength seven or more which makes our data more authentic. Our study had short duration follow-up, hence we could not comment on the complete resolution of CMT. We lacked a control group.

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