

## Macular Thickness Measured By Optical Coherence Tomography after Uneventful Manual Small Incision Cataract Surgery and Correlation with Postoperative Visual Acuity

\*Dr Ajay Shankar Kar<sup>1</sup>, Dr James S. K. Adams<sup>2</sup>

<sup>1</sup>Assistant Professor, Department of Ophthalmology, GIMSR, Visakhapatnam, India.

<sup>2</sup>Consultant, Agarwal Eye Hospital, Visakhapatnam, India.

Corresponding author: \*Dr Ajay Shankar Kar

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### Abstract:

**Background:** Macular edema is known to cause decreased vision post operatively after cataract extraction and Intra Ocular Lens (IOL) implantation. In this study we correlated the post-operative visual acuity following uneventful Manual Small Incision Cataract Surgery (MSICS) and IOL implantation with macular thickness measured by Optical Coherence Tomography (OCT).

**Methods:** In this study 62 patients between 45 to 90 years who were assigned to undergo MSICS with IOL implantation under local anaesthesia were selected. Detailed pre operative ophthalmic examination including BCVA using the Log MAR chart, slit-lamp examination and fundus examination was done. OCT measurements were done pre-operatively, between 1<sup>st</sup> day to 3<sup>rd</sup> day, 7<sup>th</sup> to 10<sup>th</sup> day and at 6 weeks. These measurements were then correlated with log MAR best corrected visual acuity.

**Results:** In our study the average macular thickness increased by 32.72 $\mu$  (15.6%) in foveal minimum, 32.53 $\mu$  (11.72%) in fovea, 28.25 $\mu$  (8.50%) in inner quadrant and 24.65 $\mu$  (11.00%) in outer quadrant, compared to preoperative base line measurement and six weeks. A definite positive correlation between macular thickness and BCVA was observed in our study. There was no statistically significant change found in visual acuity from immediate post operative period to six weeks even though there was a linear average increase in foveal thickness up to six weeks.

**Conclusion:** No significant change in visual acuity from immediate post operative period to six weeks was found, even though there was a linear average increase in foveal thickness up to six weeks

**Key Words:** Macular Edema, MSICS-Manual Small Incision Cataract Surgery, OCT-Optical Coherence Tomography, Log MAR –Logarithm of Minimum Angle of Resolution, BCVA - Best Corrected Visual Acuity, MFT- Mean Foveal Thickness, Foveal Minimum.

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### I. Introduction

Macular edema is known to cause decreased vision post operatively after cataract extraction and Intra Ocular Lens (IOL) implantation.<sup>1</sup> Abnormal fluid accumulation in the retina causes concomitant increase in the thickness of the macula. The accumulated fluid defocuses the image on the retina, thus reducing the visual acuity.

Cystoid macular edema (CME) is documented clinically in 0.6% to 6% of eyes after phacoemulsification.<sup>2</sup> The aetiology of CME has been attributed to the type of cataract surgery, intactness of the posterior capsule, vitreous loss, iris incarceration, prolonged surgical time, light toxicity, inflammatory mediators and vitreo macular traction.<sup>3</sup> It is clear that CME causes decreased visual acuity, but less is known about how smaller degrees of macular thickening correlate with visual acuity.<sup>4</sup>

It has been postulated that after cataract surgery inflammatory mediators from the anterior chamber diffuse posteriorly into the vitreous, resulting in the leakage of retinal vasculature.<sup>3</sup> It is known that prostaglandin release and tractional forces on the macula play an important role. It has been hypothesized that operative irritation induced by cataract surgery stimulates ocular tissues, especially the iris and uvea, to produce prostaglandins.

Traditional methods of evaluating macular thickness including slit-lamp biomicroscopy, stereo fundus photography and angiography are relatively insensitive to small changes in the retinal thickness. Optical Coherence Tomography (OCT) is a noncontact, non-invasive, in vivo cross sectional imaging of the retina with high axial resolution of 10 $\mu$ m.<sup>5</sup> Retinal mapping using OCT software has also shown to be a reproducible measure of retinal thickness.<sup>6</sup> Hence OCT has been chosen as the method of studying the macular thickness

over other techniques of objective evaluation in this study in view of its high resolution, contrast, repeatability and reproducibility.<sup>7</sup>

OCT uses “low coherence interferometry” to perform the high resolution time and distance measurements. The distances and dimensions of different ocular structures can be determined by measuring the echo time delay of the light that is back reflected or back scattered from the different structures at varying axial distances.

The correlation of OCT macular thickness with visual acuity postoperatively after phacoemulsification has been studied extensively. These studies concluded that there is a significant correlation between the foveal minimum macular thickness and best corrected visual acuity at day 1 and six weeks after surgery. Lower visual acuity has been documented in participants with increased macular thickness,<sup>8,9</sup>

However phacoemulsification accounts for only 10% cataract surgery in India. Since small incision cataract surgery is the commonest technique in India, in our study we intended to correlate the OCT macular thickness with best corrected visual acuity following uncomplicated small incision cataract surgery in Indian eyes. To the best of our knowledge, this is the first study involving estimation of macular edema in MSICS.

## II. Material And Methods

This observational cohort study was conducted after approval from ethical and scientific committee of Hospital and after detailed history, clinical examination, informed and written consent of all patients, 62 patients aged 45 to 90yrs., of either sex with adequate media clarity for OCT scans acquisition. and absence of pre-existing ocular disease limiting visual potential who were to undergo MSICS with IOL implantation were included in study. The correlation ( r ) between macular thickness and BCVA was found to be +0.34 from the study done by Nicholas et al.<sup>4</sup> which was taken into account for the calculation of the sample size for our study . Study participants were operated by surgeons with experience of more than 250 cataract surgeries.

Patients with combined surgical procedure (trabeculectomy with cataract extraction), conditions of the eye compromising vision (amblyopia, glaucoma, diabetic retinopathy, macular degeneration) , axial length (<21 or >26) mm, intra operative complications of cataract surgery: posterior capsular rent, vitreous loss, hyphaema, nucleus drop, zonular dialysis, post operative complications: corneal edema, posterior capsular opacity, hyphaema, cystoid macular edema and endophthalmitis, interfering with visual acuity were excluded.

Participants underwent a detailed pre operative ophthalmic examination which included best corrected visual acuity (BCVA) using the Log MAR chart, slit-lamp examination, fundus examination. OCT measurements were done pre-operatively, between 1st day to 3<sup>rd</sup> day, 7<sup>th</sup> to 10<sup>th</sup> day and at 6 week at Agarwal Eye Centre, Visakhapatnam, using Zeiss OCT Stratus 4 model. Three series of 6 scan was taken and macular thickness map was derived. Data for macular thickness as central minimum, fovea, 4 quadrants of inner retina and 4 quadrants of outer retina were taken. To provide continuous data for statistical analysis visual acuity of counting fingers was converted to 6/300, hand movements to 6/600 and perception of light to 6/1200.

## III. Statistical Methods

All OCT parameters were entered in an MS Excel 2000 spreadsheet. Statistical analysis was performed with SPSS 11.0 software for Windows (SPSS Inc. Chicago: IL). Descriptive statistics (mean, standard deviation, median and range) were calculated for all parameters. The correlation between macular thickness and visual acuity was assessed with Spearman correlation coefficient. The percentage change in macular thickness from pre operative base line value to other time part were calculated and tested by Signrank test.

**Table 1:** Distribution of baseline parameters

Baseline Parameters	
Total number	62
R:L eye	36:26
Male: Female	40:22
Mean Axial length with SD in mm	22.94(0.75)

**Table 2:** Mean and Standard Deviation Macular thickness in all quadrants in  $\mu$  (n=62)

Average thickness in	Pre-op	Day 1-3	Day 7-10	Day $\square$ 6 wk
<b>Foveal minimum</b>	153.56 $\pm$ 23.92	162.90 $\pm$ 26.71	169.15 $\pm$ 31.81	191.28 $\pm$ 64.04
<b>Fovea</b>	179.37 $\pm$ 21.92	184.74 $\pm$ 23.70	189.48 $\pm$ 25.37	211.90 $\pm$ 59.45
<b>Inner quadrant</b>	243.27 $\pm$ 26.6	249.88 $\pm$ 23.75	258.65 $\pm$ 24.68	271.52 $\pm$ 38.98
<b>Fovea+ Inner quadrant</b>	288.11 $\pm$ 29.9	296.07 $\pm$ 27.65	306.07 $\pm$ 28.87	324.50 $\pm$ 51.82
<b>Outer quadrant</b>	215.89 $\pm$ 19.15	225.80 $\pm$ 17.30	230.92 $\pm$ 19.05	240.5 $\pm$ 21.63

Table 2 shows that there is an increase in average macular thickness in foveal minimum, fovea and all the quadrants post operatively compared to preoperative values.

**Table 3:** Percentage change in macular thickness between each time period (and the related P-values) for each of the macular parameters (n=62)

Time period	Foveal minimum	Fovea	Inner quadrant	Fovea + inner quadrant	Outer quadrant
Before Sx to day 1-3 in %	4.03 P<0.0001	1.76 P<0.0001	1.33 P<0.0001	1.69 P<0.0001	3.72 P<0.0001
Day 1-3 to Day 7-10 in %	1.20 P=0.016	1.92 P=0.034	3.73 P<0.0001	3.58 P<0.0001	2.59 P<0.0001
Day 7-10 to □6weeks in %	5.19 P<0.0001	5.69 P<0.0001	2.91 P<0.0001	3.51 P<0.0001	3.34 P<0.0001
Before Sx to □6weeks in %	15.6 P=0.0002	11.72 P<0.0001	8.50 P<0.0001	9.28 P<0.0001	11.00 P<0.0001

Table 3 shows the percentage change in average macular thickness during the study period. Post operative increase in macular thickness was statistically significant in all the quadrants. Average macular thickness increased by 15.6% in foveal minimum, 11.72% in fovea, 8.50% in inner quadrant and 11.00% in outer quadrant, compared to preoperative base line measurement and six weeks.

**Table 4:** Correlation between macular thickness and best corrected visual acuity (Spearman Correlation Coefficient with P- values, n=62)

Time	Foveal minimum	Fovea	Inner quadrant	Fovea+inner quadrant
Day 1-3	0.46 P=0.0001	0.81 P=0.0001	0.27 P=0.02	0.42 P=0.0007
Day 7-10	0.44 P=0.0002	0.37 P=0.001	0.24 P=0.04	0.38 P=0.0015
□ 6 weeks	0.47 P=0.0001	0.48 P=0.0001	0.36 P=0.02	0.41 P=0.0005

Table 4 shows significant positive correlation was found between BCVA and fovea, foveal minimum and inner quadrant thickness, at 1- 3 days, 7 - 10 days and at 6 weeks. At day 1-3 days, there was a strong correlation between foveal thickness and visual acuity ( $r = +0.81$ ). However at 6 weeks there was only a moderate correlation ( $r = + 0.48$ ), suggesting that the visual acuity did not change much with foveal thickness at 6 weeks.

**Table 5:** Comparison of average foveal thickness in  $\mu$  and visual acuity in log MAR (n=62)

Days	Av. foveal thickness in $\mu$	Av. VA in log MAR	P value
Day 1-3	184.7	0.1	0.006
Day 7-10	189.4	0.1	0.003
> 6 weeks	211.9	0.1	0.48

Table 5 illustrates that even though there is a linear increase in average foveal thickness from day one to 6 weeks post operatively, the visual acuity has not decreased.

**Table 6:** Comparison of Visual acuity (VA) at 6 weeks, corrected to Log MAR second decimal and Change of foveal thickness at 6 weeks from base line value. (n=62)

VA @ 6 wk compared to that at 1-3 D	Number of participants	Number of participants in %	Change in foveal thickness in $\mu$ (median, IQR)	VA difference in log MAR
Drop in VA	8	12.9 %	31.5(17-63)	- 0.02
Improvement in VA	19	30.6 %	13(9-37)	+ 0.04
No change in VA	35	56.5 %	23(13-36)	0.00

Table 6 shows at 6 weeks 87.1 % of participants had same or improved vision as compared to first 3 days post operative vision, even when there was increase in foveal thickness from the base line value.

#### IV. Discussion

To the best of our knowledge there are no published studies correlating post- operative macular thickness and best corrected visual acuity (BCVA), following uneventful manual small incision cataract surgery (MSICS). This study was undertaken to correlate post-operative macular thickness by OCT and BCVA by Log MAR, at a tertiary health care centre following uncomplicated small incision cataract surgery.

In our study there was a mean increase in average macular thickness in all sub quadrants from the base line values and the measurement taken at 6 weeks post operative visit. The average increases in are shown below:

- Average increase in fovea minimum from baseline to 6 weeks was 37.72  $\mu$ .
- Average increase in fovea from baseline to 6 weeks was 32.53  $\mu$ .
- Average increase in inner quadrant from baseline to 6 weeks was 28.25  $\mu$ .
- Average increase in outer quadrant from baseline to 6 weeks was 24.65  $\mu$ .

When the macular thicknesses were assessed at various intervals from first day of surgery up to 6 weeks, it showed a gradual linear increase in the average macular thickness up to 6 weeks.

Average increase in percentage change in macular thickness comparing the preoperative and post operative values was significantly less in our study group as compared to Nicholas et al.<sup>4</sup> In our study macular thickness had not begun to normalize even at 6 weeks after surgery. Study by Nicholas et al<sup>4</sup> also showed that macular thickness had not normalised at 6 weeks except in the outer macular quadrants. Studies by Carlo Cagini et al<sup>8</sup>, Lobo et al<sup>10</sup>, Jureks et al<sup>11</sup>, Kim et al<sup>12</sup> and Kecik et al<sup>13</sup> showed significant increase in macular thickness after 4 weeks post surgery.

In our study there was a linear increase in average foveal thickness from day one to 6 weeks , but the visual acuity of the participants did not drop from day 1 to 6 weeks . Similar findings were seen in the following studies:

- Nicholas et al<sup>4</sup> found that the correlation between macular thickness and BCVA varied in strength with only the foveal minimum parameter showing significant positive correlation.
- Burkhard von Jagow et al<sup>9</sup> found that after cataract surgery there was an increase of mean foveal thickness (MFT) from day one (MFT=+10.66 $\mu$ ) ,day 7 (MFT=+5.23  $\mu$ ) and week 6 (MFT=+17.33  $\mu$ ) from the preoperative base line values. However the study concluded that there was no correlation between BCVA and increased foveal thickness.
- Carlo Cagini et al<sup>8</sup> also found that the retinal thickness and macular volume showed a statistically significant increase at the 12th week after surgery, however there was no correlation between macular changes and BCVA.
- Kim et al<sup>12</sup> also found that there was an increase in mean foveal thickness from pre operative value (MFT =180.5  $\mu$ ) to post operative value at 6 weeks (MFT =196.7  $\mu$ ) with BCVA improvement of 2.5 lines at 6 weeks. A definite positive correlation between macular thickness and BCVA was inferred which was agreeable with our study.

In our study a strong positive correlation ( $r = +0.81$ ) was found between average foveal thickness and BCVA in the immediate post operative period ( 1 to 3 days ). A moderate positive correlation ( $r = +0.48$ ) was found between average foveal thickness and BCVA at 6<sup>th</sup> week follow up visit..

Our study has certain limitations. The sample size is small and duration of follow up is 6 weeks postoperative period. To determine the pattern of change in the foveal thickness, a longer duration of follow up, of 3 to 6 months, with a larger sample size, may be required.

## V. Conclusions

1. There was a linear increase in average macular thickness in all quadrants during the first six weeks of post operative period.
2. A strong positive correlation was found between average foveal thickness and visual acuity at immediate post operative period.
3. A moderate positive correlation was found between average foveal thickness and visual acuity at 6 weeks.
4. There was no statistically significant change in visual acuity from immediate post operative period to six weeks even though there was a linear average increase in foveal thickness up to six weeks.

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