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Foveal thickness alteration following uncomplicated cataract surgery- An OCT based study

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Abstract
Introduction: *Cataract is the commonest cause of treatable blindness world-wide, and surgery is the only fruitful modality of its treatment for visual recovery.Clinically macular edema is one of the reported complication after cataract surgery due to inflammatory response. This macular edema could have an effect on final visual acuity so this study was undertaken to evaluate the clinical or sub-clinical alteration in macular thickness after cataract surgery and its effect on visual acuity.*
Materials and Method: *180 cataractous eyes posted for surgery were enrolled for study after following the exclusion criteria. All patients underwent OCT macular scan analysis for the central 1mm macular zone to look for macular edema and best corrected visual acuity pre operatively followed by the 1st post op day, 4th week and 12th week after cataract surgery.*
Results: *The difference between the preoperative and post operative central subfield and average macular thickness was highly significant after the 4th week of surgery (p=<0.001) while the difference between the preoperative and post operative macular volume (mm^3) was found to be highly significant after the 4th and 12th week of surgery (P<0.001). Despite these findings, visual acuity increased significantly by 4th and 12th week of surgery.*
Conclusion: *Post cataract surgery there occurs an increase in macular thickness which is either clinically or tomographically evident but has no statistically significant correlation with the final visual outcome.*
Keywords: *Cataract, macular thickness, optical coherence tomography.*

Introduction

Cataract accounts for approximately 20 million (47%) cases of blindness worldwide (WHO, 2007)[1]. Approximately two-thirds of people with cataract blindness live in the Asian subcontinent, China and sub-Saharan Africa.

The cataract burden is likely to increase as the global population is not only increasing but also ageing[2]. It is seen in more than 60% of the population above the age of 50 years (Vision 2020, 2011)[3].

Surgery is the only recommended option for the management of cataract. As with all surgeries,

cataract surgery is also not free from complications. Post-operative macular edema is one of the most commonly reported accompaniment of cataract surgery as a result of post-surgical inflammatory cascades.[4,5,6,7] There occurs an increased perifoveal capillary permeability and breakdown of blood retinal barrier, resulting in accumulation of fluid in macular layers.[8]

As a result of this edema, a change in macular thickness is observed. Most of the studies using optical coherence tomography (OCT) have reported an increase in macular thickness following cataract surgery[9,10,11], however, some rare studies have also reported a decrease in macular thickness[12]. Although change in macular thickness diminishes with passage of time yet it lasts over a long period.[5,6,13]

In available literature there are conflicting evidences showing impact of macular thickness on best corrected visual acuity (BCVA). Significant inverse correlation between macular thickness and BCVA has been reported by some[14], while other studies indicated insignificant correlation between them[15,10], and still other also showed a positive correlation with foveal thickness and visual acuity[9].Thus showing an unconfirmed and confounded impact of foveal thickness on visual acuity following uncomplicated cataract surgery.

In view of these conflicting reports the present study was undertaken to look for obvious or ambiguous macular edema by OCT and to analyze its effect on visual acuity.

Material & Methods

A cross sectional study was conducted at a tertiary Medical College in North India after being approved by an institutional review board.240 cataractous eyes who were posted for cataract surgery were enrolled for the study. Of them, 32 patients with previous history of any intraocular surgery, history of uveitis, age related macular degeneration, patients presenting with total media opacity, traumatic cataract, proliferative diabetic retinopathy, patients ontopical prostaglandin medication for glaucoma, history of cataract surgery in fellow eye <6 months were excluded from the study. Rest all underwent OCT macular scan for preoperative macular edema. Four patients were found to have macular edema and hence were also excluded. Further 20 patients were excluded due to either intraoperative or post-operative complications. So the remaining 184 patients formed the study group.In all these patients detailed clinical examination was done which included assessment of visual acuity by Snellen's chart, anterior segment assessment by torch light and slit lamp examination, fundus examination using + 90D Lens and direct ophthalmoscopy and IOP by applanation tonometer. Four patients were later on lost to follow up so in all we were left with 180 patients. All included subjects were scanned with the Cirrus SD-OCT (software version 4.0) Carl-Zeiss Meditec Inc., Dublin, CA) by a single operator both preoperatively and on 1st post- operative day, 4th week and 12th week after cataract surgery to look for any macular thickness changes.

All data was compiled and analysed statistically using Statistical Package for Social Sciences, Version 18.0.Fast track retinal tracking system along with the foveal finder system was used for precise macular thickness analysis. Macular thickness was reported in a predefined Early Treatment of Diabetic Retinopathy Study macular map with the central subfield having diameters of 3mm and 6mm respectively. The retinal thickness in the inner and outer subfield, the central foveal thickness (CFT), the centre point thickness (CPT) and the macular volume were calculated. CPT was defined as an average of 6 radial scans centred at the foveola, whereas the CFT was defined as the average of all points within the central 1mm diameter circle surrounding fixation[16]. BCVA values were converted to the logarithm of the minimal angle of resolution (log MAR) units. A data was presented as mean + - SD. Fisher's exact test or chi square 2testwas used to compare the groups whenever appropriate. Mean foveal

thickness and volume was recorded on each visit and compared by statistical test by two sample unpaired and paired 't' test. Post-operative relationship between the foveal thickness change and best corrected visual acuity was done by Anova test. p< 0.05 was considered as significant.

Result

We evaluated 180 patients above 45 years of age, irrespective of gender, with an aim to measure the macular thickness following uneventful cataract surgery and then to study its impact on post-cataract surgery visual outcome. Distribution of patients was done according to age, gender and the type of surgery they underwent i.e. small incision cataract surgery (SICS) or phacoemulsification.

Small incision cataract surgery (SICS) was performed on a total 40 (37.03 %) males and 68 (62.96%) female patients. While phacoemulsification (phaco) surgery was performed on a total 28 (38.88%) males and 44 (61.12%) female patients, with maximum number of patients in the age group of 55-65 years in both the groups. The variation in the mean age between male and female patients was not statistically significant (p=0.295) (table-1).

OCT was done in all patients both pre and post operatively to look for central subfield thickness, average macular thickness and macular volume. Their findings and comparison, for SICS group is shown in table 2 and for phacoemulsification group in table 3.

We looked for the mean centre sub-field thickness pre-operatively as well as post operatively on day 1, 4thweek and 12thweek after surgery and we found that the difference between preoperative and postoperative mean central subfield thickness quantified after time interval of 4 weeks postoperatively was highly significant in both the groups (p<0.001)

The difference between preoperative and postoperative mean macular thickness was also found to be highly significant after a time interval of four and twelve weeks postoperatively in both SICS and phacoemulsification group(p<0.001). The comparison of mean macular volume between the preoperative and postoperative periods was carried out and it was found to be significant only after fourth week in SICS group (p<0.001) but both after fourth week and twelfth week of surgery in phacoemulsification group (p=0.001).

The percentage change in thickness between the first postoperative day and fourth week postoperatively and also between 1st postoperative day and twelfth week postoperatively, was statistically significant with p-value <0.001 and P= 0.010 respectively. On looking for the percent change in thickness after one day and four weeks and four weeks to twelve weeks it was found to be significant (p<0.001) only at four weeks. Change in percent volume was significant at fourth week postoperatively (p<0.001).

The difference between the preoperative and post-operative best corrected visual acuity (Log MAR) was assessed and itwas found to be highly significant during the aforementioned time periods in both small incision cataract surgery and phacoemulsification surgery group. (p=<0.001) (table-4)

Although Pearson correlation of foveal thickness against best corrected visual acuity values was positively correlated at all times post-operatively but the findings were statistically insignificant. (Table-5)

Distribution of study group

Table 1: Sex and Age distribution according to type of Surgery

Age categories	Male (N=68)		Female (N=112)		Total n=180
	SICS (n=40)	Phaco (n=28)	SICS (n=68)	Phaco (n=44)	
45-55	3 (7.5%)	1 (3.6%)	8 (11.7%)	2 (4.5%)	14 (7.78%)
55-65	20 (50%)	16 (57.1%)	34 (50.0%)	23 (52.3%)	93 (51.66%)
>65	17(42.5%)	11 (39.3%)	26 (38.2%)	19 (43.2%)	73 40.56%
Mean±SD	**57.10±12.2**		**59.12±12.6**		**P value= 0.293**

Table 2: Comparison of Central subfield thickness (in µm), average macular thickness (in µm) and macular volume (mm^3) between Preoperative and Postoperative period for small incision cataract surgery group (SICS):

	SICS (N=108)		P value
	Preoperative	Postoperative	
Central Subfield thickness (in µm)			
1 day after surgery	234.1±17.0	235.9±24.3	0.528
After 4 week		246.7±25.3	0.001
After 12 week		239.4±26.3	0.080
Average thickness(µm)			
1 day after surgery	244.9±22.5	248.5±21.1	0.226
After 4 week		261.0±20.9	0.001
After 12 week		252.0±20.8	0.016
Volume (mm3)			
1 day after surgery	9.1±0.69	9.2±0.71	0.295
After 4 week		9.5±0.67	0.001
After 12 week		9.3±0.65	0.029

2paired t-test,

Table 3: Comparison of central subfield thickness (in µm) , average macular thickness (in µm) and macular volume(*mm^3) between preoperative and postoperative period for Phacoemulsification surgery group

	Phacoemulisification (N=72)		P value
	Preoperative	Postoperative	
central subfield thickness (in µm)			
1 day after surgery	238.3±19.0	239.3±26.2	0.793
After 4 week		250.9±26.3	0.001
After 12 week		243.0±24.3	0.198
Average thickness(µm)			
1 day after surgery	252.9±22.5	256.5±21.1	0.323
After 4 week		269.0±21.2	0.001
After 12 week		261.0±20.9	0.026
Volume (mm3)			
1 day after surgery	9.3±0.69	9.6±0.72	0.117
After 4 week		9.9±0.69	0.001
After 12 week		9.7±0.64	0.001

Table 4: Comparison of best corrected visual acuity between preoperative and post-operative periods of both small incision cataract surgery and phacoemulsification group and the total of both the groups (SICS+ PHACO)

	SICS (N=108)		P value	Phaco (N=72)		P value	Total (SICS+ PHACO)	P value
	Preoperative	Postoperative		Preoperative	Postoperative			
1 day after surgery	0.40±0.16	0.53±0.24	<0.001,	0.44±0.18	0.57±0.26	<0.001*. <0.001*	0.55±0.23	<0.001
After 4 week		0.26±0.22	<0.001, <0.001*		0.30±0.26	<0.001* <0.001**	0.28±0.44	<0.001* <0.001**
After 12 week		0.13±0.20	<0.001, <0.001#		0.17±0.24	<0.001*, <0.001#	0.15±0.22	<0.001* <0.001#

Table 5: Correlation between foveal thickness and visual acuity of study group

	Visual Acuity			
Foveal thickness	**Pre- op**	**1 Day**	**4 week**	**12 week**
Person correlation (r value)	0.085	0.273	0.134	0.112
P value	0.524	0.060	0.433	0.414

Table 6: Average % Change

	% change between pre-op and 1st post op day	% change between 1st post op day and 4th week post op	% change between 4th week and 12th week post op
Average central subfield thickness	0.6±12.6	19.2±11.5	12±11.3
P value		<0.001	0.010
Average percentage change in macular volume	1.3±3.6	4.6±5.5	2.9±5.1
P value		<0.001	0.086
Average percentage change in average macular thickness	2.4±4.4	4.1±5.2	3.0±5.4
P value		<0.001	0.248

Paired t-test

Discussion

Cystoid macular oedema (CME) is a cause of visual impairment after cataract surgery. Surgical trauma to the iris, ciliary body and lens epithelial cells causes release of phospholipids and thereby release of prostaglandins or other inflammatory mediators. The inflammatory mediators diffuse through the vitreous and disrupt the blood retinal barrier to cause pooling of serum in retina resulting in macular oedema [17,18]

Although cystoid changes in CME are visible by slit-lamp biomicroscopy and fluorescein angiography, only OCT can quantitatively assess the retinal thickness with demonstration of any associated structural anomalies of retinal pigment epithelium (Voo et al. 2004).[19]

This cross sectional study was done with an aim to measure the macular thickness following uneventful cataract surgery (phacoemulsification and small incision cataract surgery) with intra ocular lens implantation and then to study its impact on post cataract surgery visual outcome.

The difference between preoperative and postoperative mean central subfield thickness was significant with P<0.001 and P=0.032 after a time interval of 4 weeks and 12 weeks postoperative respectively. We also analyzed the percentage change in central subfield thickness during the post operative period. The percent change was highly significant when compared from the first postoperative day to 4th week after surgery. (P<0.001)

In previous studies, subclinical macular thickening has been reported after uncomplicated cataract surgery (Nicholas S et al.[20], Von Jagow B et al[4], Perente I et al[21], Cagini C et al[10], Biro Z et al[22], Kusbeci Tet al[23]).Cagini C et al[10] in their study indicated that the onset of clinically

significant CME is rare after uncomplicated phacoemulsification, but with respect to preoperative values they observed an asymptomatic increase in macular thickness and volume at 12th week.

On assessing the mean macular volume we found a statistically significant difference between the preoperative and postoperative macular volume at all post-operative times with p value of p=o.oo7,p=<0.001 and p=<0.001 after 1stpost operative day, 4th week after surgery and 12th week after surgery respectively.

We also analyzed the percentage change in the macular volume during the post operative period The percent change was found to be highly significant after the1stpost operative day to 4th week (P<0.001).

On looking for average macular thickness we found that the maximally significant change in the macular thickness was seen at 4th week after surgery (p=<0.001) while in studies done by Nicholas s et al[20] and Van Jagow B[4]retinal thickness showed significant increase on the 1st post op day itself. On the contrary in a study by Perente I et al[21] a mild statistically in signifcant decrease in the macular thickness was seen after cataract surgery.

Ghosh S et al[24] did phacoemulsification with foldable acrylic lens and manual small incision cataract surgery (MSICS) and reported that on the first postoperative day, central subfield mean thickness (CSMT) in MSICS group and that in phacoemulsification group did not show any significant difference (p = 0.12). But with passage of time ie. by 42 days this difference became significant(p=0.007).

Similarly we also found an increase in macular thickness post operatively in both SICS and phacoemulsification group but with no significant difference between them at any time. In another study done by Kurz S et al[25] statistically significant difference between groups was found in mean foveal thickness at day 1 postoperatively (p=0.027). No significant differences between groups in mean macular volume were found at day 1 or at 4 and 8 weeks postoperatively. Hwang HS et al[26] reported that microincision coaxial cataract surgery may increase the macular thickness compared to small incision coaxial cataract surgery. Blood-aqueous barrier breakdown may occur more frequently after microincision cataract surgery than after small incision cataract surgery.

Further we analyzed the effect of macular changes on post operative best corrected visual acuity (Log MAR). The mean of the BCVA significantly improved after cataract surgery with an upward trend towards improvement by the 4th week (p=<0.001) and 12th week (p=<0.001). as compared to the 1stpost operative day even though the macular thickness was increased post operatively and maximal increase was seen by the 4th week in both manual small incision cataract surgery as well as phacoemulsification surgery group and thus showing no significant correlation between foveal thickness and visual acuity in subsequent time interval. While Sourdille and Santiago (1999)[27], as well as Cheng and colleagues (2002)[12] found in their studies that the BCVA was inversely related to the foveal thickness in the early postoperative period . Georgopoulos GT et al[28] also reported no correlation between foveal thickness and visual acuity.

Conclusion

OCT yields accurate retinal thickness measurements with high reproducibility. Although OCT reveals a statistically significant increase in the macular thickness after cataract surgery, the visual acuity instead of deteriorating improved after cataract surgery, thus showing no correlation between increased macular thickness and post-operative visual acuity unless the increase in the macular thickness is clinically detectable. However, a possible limitation of the present study was that we were not able to assess very dense cataracts which may require greater amount of phacoemulsification energy and due to which the final visual outcome may vary.

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