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Correlation between anterior chamber depth changes and post operative refractive error after phacoemulsification

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ABSTRACT

Aim: There is an increase in patient demands and satisfaction with post-operative visual recovery. There are numerous factors affecting post-operative visual outcomes. One of the factors is the change in anterior chamber depth post-operatively. The following study was planned to assess the changes in anterior chamber depth post- operatively and determine the correlation with post-operative refractive errors in patients who had cataracts and underwent phacoemulsification with intraocular lens (IOL) implantation.

Materials and Methods: This prospective cohort study was conducted in 120 eyes. The cases diagnosed with cataract underwent phacoemulsification. Preoperative and post-operative anterior chamber depths were obtained and post-operative spherical equivalent of refractive errors were noted at 4 weeks.

Results: Smaller anterior chamber depths had a larger amount of deepening of the anterior chamber (ACD difference>1.22mm) after cataract surgery and vice versa (r= -0.46, p<0.01). Post-operative refractive error showed hyperopic shift when the change in AC depth was small (<1.22mm) and myopic shift when the change in AC depth was large (>=1.22mm).

Conclusion: There is a definite correlation between AC depth difference and post-operative spherical refractive error (r= -0.41, p<0.01).

1. Introduction

Phacoemulsification with foldable IOL implantation is now the well- established and preferred method for the management of cataracts. Patient expectations are high about postoperative visual outcome. Also, there is an emerging trend of newer multifocal premium IOLs. Thus, the need for ensuring postoperative emmetropia is high. Standard practice involves good preoperative assessment and accurate IOL power calculation. Despite of that the incidence of postoperative refractive surprise is not uncommon. According to a study by Olsen, post operative refractive error of 9–20 percent of patients is greater than one diopter.[1] The post-operative refractive outcome following cataract surgery is affected by a variety of factors. The assessment of ocular parameters such as keratometry, axial length and lens thickness, surgically induced astigmatism, intraoperative handling, the choice of IOL calculation formula, and the location of IOL implantation are among the most frequent factors.[2] Perhaps the most crucial and modifiable of these is IOL power. Most commonly used IOL power calculation formula SRK/T considers axial length, keratometry and lens constant.[3]

In light of the well-established reliability of axial length and keratometry, the effective lens position (ELP) is considered an important factor affecting the predicted refractive error.[4] After the placement of an artificial lens, the iridocorneal angle widens, and AC deepens.[5] The effective lens position will determine the postoperative anterior chamber depth.[6] We thus planned to study the changes in

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anterior chamber depth postoperatively and to study their correlation to postoperative refractive error.

2. Materials and Methods

This is a prospective cohort study conducted in the Ophthalmology department of a tertiary care hospital in southern Maharashtra. After the institutional ethics committee approval, written informed consent was taken. The study was conducted in 120 eyes of 88 patients.

2.1. Inclusion criteria

Nuclear sclerosis (NS) grade 1 to 3 uncomplicated cataract undergoing phacoemulsification.

2.2. Exclusion criteria

Any other grade of cataract, preoperative astigmatism [>=1 Dioptre], eventful cataract surgery, patients with other ocular diseases like glaucoma, keratoconus, pterygium, retinal detachment, vitreous hemorrhage, axial length>27mm. Cases who had post-operative astigmatism [>=1 Dioptre] were excluded.

All cases underwent a detailed ophthalmic evaluation which consisted of visual acuity, anterior segment assessment and dilated fundus examination. They underwent phacoemulsification with foldable IOL implantation (Acrysof IQ/ Acrysof plain). All cases were operated by a single surgeon.

Preoperatively following parameters were documented:

Anterior chamber depth (ACD) (mm), Axial length (AL)(mm), Keratometry (Dioptre), IOL power (Dioptre). All measurements were done using an optical biometer (Aladdin, Topcon). IOL power was calculated using the standard SRK/T formula.

Post-operatively ACD (mm) and Refractive error (Dioptre) were recorded on 4^{th} weeks post-operatively. ACD was measured using an optical biometer and refractive error was recorded with autorefractometer. Myopic spherical refractive error was defined as refractive errors with value [>=-0.25D] and hyperopic spherical refractive errors were defined as [>=+0.25D].

2.3. Statistical analysis

All statistical analysis was done using SPSS software with version 26.0. Continuous variables results (Age) were shown by descriptive statistics and categorical variables results (Gender, spherical refractive error) were shown by frequency and percentages. Continuous variables were analyzed using the student paired t -test (AC depth). Spearman's test, Pearson's test were used to find out the correlation between different continuous parameters and ordinal variables (AC depth difference and post op spherical refractive error, AC depth difference. P value<0.05 considered as significant.

3. Results

3.1. Demographic results

A total of 120 patients with nuclear sclerosis (NS) grade 1 to 3 uncomplicated cataracts undergoing phacoemulsification were included in our study. The average age of the patient was 64.24 ± 7.65 years, ranging between 38 to 83 years. Out of 87 patients recruited 46 (54.2%) were males and 41 (45.8%) were females.

3.2. Anterior chamber depth

The difference between pre and post anterior chamber depth was 1.2 ± 0.2 mm. The difference in the means of anterior chamber depth was compared using the student t- test. There was a significant (<0.01) difference between pre and post-surgery anterior chamber depth values. (Table 1)

There were 36 (30%) eyes with myopic spherical refractive error, 30 (25%) eyes with hyperopic spherical refractive error and 54 (45%) eyes with nil spherical refractive error.

Comparison of ACD and ACD difference shows a statistically significant negative correlation when compared in overall spherical refractive error and also when compared separately.(Table 2)

The range of myopic spherical refractive error existed from -0.25D to -1.00D. The range of hyperopic spherical refractive error ranged from +0.25D to +1.50D.

A significant (p<0.001) negative association between overall postoperative spherical refractive error and difference in anterior chamber depth was reported in the present study with r value of -0.41.(Table 3)

Similarly, the correlation of anterior chamber depth difference was studied with specific postoperative spherical refractive error. The results were inconsistent to that of the overall correlation for all spherical refractive errors. (Tables 4 and 5)

4. Discussion

A total of 120 patients with nuclear sclerosis (NS) grade 1 to (NS) grade 3 uncomplicated cataracts underwent phacoemulsification by a single surgeon with a foldable acrylic lens. The mean age of the patients was 64.24 ± 7.65 years, ranging between 38 to 83 years.

In accordance with previous reports we also found a significant difference between pre and post-surgery anterior chamber depth.[6] The anterior chamber deepened, with a significant increase in post-surgery value after 4 weeks compared to pre-surgery values. The average deepening of ACD noted is 1.22mm with a p-value <0.001.

On studying the post-operative refractive error profile we found the incidence of myopic spherical refractive error was

Table 1: Comparison of pre and post anterior chamber depth

Anterior chamber depth(mm)	Pre		Post		P value
	Mean	SD	Mean	SD	
N=120	3.2	0.3	4.4	0.3	<0.001

*Paired t-test

Table 2: Correlation of preoperative anterior chamber depth with ACD difference (ACD D)

Type of spherical refractive error	Pearson correlation	P value
Overall (n=120)	-0.46	<0.001
Myopic(n=36)	-0.31	<0.03
Hyperopic(n=54)	-0.54	<0.001

Table 3: Correlation of anterior chamber depth difference and post-operative spherical refractive error: Overall spherical R.E (n=90)

AC Depth (mm)				r	p
Minimum	Maximum	Mean	Difference		
2.00	4.00	3.21	1.23	-0.41	<0.001

Table 4: Correlation between each post op spherical refractive error with Anterior chamber depth difference

Post-operative myopia (n=36)					
AC Depth (mm)				**r**	**p**
Minimum	Maximum	Mean	Difference		
2.74	3.8	3.23	1.25	0.16	0.37
Post-operative hyperopia (n=54)					
AC Depth (mm)				**r**	**p**
Minimum	Maximum	Mean	Difference		
2.05	3.91	3.17	1.24	0.19	0.16

Table 5: Distribution of post-operative spherical refractive error according to mean ACD difference = 1.22mm

Post-operative spherical Refractive error	<Mean value (1.22mm)		>Mean value (1.22mm)		Total
	n	%	n	%	
Myopic	13	36.1	23	63.9	36
Nil	19	63.3	11	36.7	30
Hyperopic	29	53.7	25	46.3	54
Total	61		59		120

Chi square = 5.17; P value=0.075 (Not significant)

Table 6: Change in anterior chamber depth in post op myopic spherical refractive errors

Spherical error(D)	Preop AC depth(mm)			Avg. ACD difference(mm)
	Minimum	Maximum	Avg. ACD	
-0.25 (n=10)	3.52	3.80	3.61	1.13
-0.50 (n=16)	3.06	3.47	3.24	1.15
-0.75 (n=9)	2.77	2.96	2.89	1.38
-1.00 (n=1)	2.74	2.74	2.74	1.44

Annova test: r= -0.46 p=0.047

Table 7: Change in anterior chamber depth in post op hyperopic spherical refractive errors

Spherical error(D)	Preoperative AC depth(mm)			Avg. ACD difference(mm)
	Minimum	Maximum	Avg. ACD	
0.25 (n= 16)	2.05	3.06	2.77	1.36
0.50 (n=20)	3.07	3.32	3.17	1.34
0.75 (n=8)	3.34	3.51	3.43	1.18
1.00 (n=7)	3.52	3.68	3.57	1.17
1.25 (n=2)	3.70	3.77	3.73	1.13
1.50 (n=1)	3.91	3.91	3.91	1.11

Annova test: r= -0.19 p=0.142

30%, while that of hyperopic spherical refractive error was 25%. 45% of total cases had nil spherical post-operative refractive error.

In our study comparison of preoperative anterior chamber depth and change in anterior chamber depth showed a strong negative correlation with statistical significance (r= -0.46, p<0.001). This signifies that smaller anterior chamber depths had a larger amount of deepening of anterior chamber (ACD difference>1.22mm) after cataract surgery. Similarly, larger anterior chamber depths had a smaller amount of deepening of the anterior chamber (ACD difference <1.22mm) after cataract surgery.

These findings are consistent when anterior chamber depth and anterior chamber depth difference are compared separately for cases with myopic spherical refractive errors (r=-0.31, p<0.03) and hyperopic spherical refractive errors (r=-0.54, p<0.001). In a similar vein to the current study, Merriam JC et al.[7] reported that the rate of change in ACD is inversely related to ACD before surgery.

Engren AL et al. studied the relationship between the IOL and the cornea and iris. They found that the average person's vision would be impacted by an ACD difference of 0.32 diopters.[8] Unlike the study done by Engren, this study could not derive the prediction of the magnitude of AC depth change post -surgery.

We attempted to determine a correlation between anterior chamber depth changes and post operative spherical refractive error. We note a significant but negative correlation between overall postoperative spherical refractive error (including hyperopic and myopic spherical refractive errors) and the difference in ACD (r=-0.41, p<0.001). This means that a hyperopic shift occurred when the change in anterior chamber depth was small (ACD difference<1.22mm) and a myopic shift occurred when the change in anterior chamber depth was large (ACD difference>1.22mm).

However, when the cases were grouped according to type of refractive error (myopic or hyperopic) and an attempt was made to determine a correlation between ACD difference and post operative spherical refractive error, we noted that the correlation was negative but insignificant in both myopic spherical refractive error category (r=0.16, p= 0.37) and also for the hyperopic spherical refractive error category (r=0.19, p=0.16). We could not find a plausible explanation for this but it could be attributed to a smaller sample size when refractive errors were compared separately. A similar study done by Ning and Yang showed a similar correlation as this study but with statistical significance in separately categorized refractive errors also.[9]

When the grouping of refractive errors was done based on mean anterior chamber depth difference (1.23mm) we observed that the majority, 64% eyes with post op myopic spherical refractive error had ACD difference above the mean value and 36% below the mean value. Marginal difference was seen in hyperopic eyes. 54% of patients with hyperopic spherical refractive error had an ACD difference below the mean value, and 46% above the mean value.

5. Conclusion

This study concludes that after cataract surgery, the anterior chamber deepens. Eyes with larger preoperative anterior chamber depth had a smaller amount of deepening of AC and resulted in more post op hyperopic spherical errors.

Eyes with smaller preoperative anterior chamber depth had a larger amount of deepening of AC and resulted in more post op myopic spherical errors.

We hence suggest from our study that anterior chamber depth may be taken into account when determining IOL power. For an accurate IOL calculation prior to cataract surgery, IOL calculation formulas that take anterior chamber depth into account (Haigis, Holladay) as a parameter may be used.[10] Further research with a larger sample size is necessary to determine the precise magnitude of the correlation between anterior chamber depth difference and postoperative spherical refractive error.

6. Source of Funding

None.

7. Conflict of Interest

None.

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