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Comparison of Changes in Amplitude of Accommodation Before and After Cataract Surgery in a Tertiary Hospital in India

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Abstract

Background: Cataract is considered to be the most common cause of age-related visual decline globally, accounting for nearly 50% of preventable blindness. There has been so much refinement and advancement in the field of cataract surgery over the past two decades, that it has progressed from a sight-restoring surgery to a vision-enhancing / refractive surgery. It is therefore important to study the characteristics of pseudophakic eyes in detail, as this may have a bearing on the visual outcomes.

Accommodation is a physiologic process by which the ciliary muscles of the eye changes the refractive power by altering the shape of the crystalline lens in order to automatically focus on objects at variable distances from the eye. It is measured in terms of the amplitude of accommodation (AA) using the unit dioptre (D). Near point of accommodation (NPA) refers to the minimum distance at which the eye can comfortably, distinctly and clearly focus on an object without strain; at this point the image of the object is accurately focused on the retina at full accommodation. NPA is calculated (cm) subjectively using the RAF Near Point Rule (RNPR). The difference between the dioptric power needed to focus at near point and focus at far point is known as the amplitude of accommodation (AA). It is maximum during childhood and decreases with advancing age. Following cataract surgery, the PCIOL does not possess any power of accommodation and thus majority of

pseudophakes have difficulty in near vision and require bifocal / progressive spectacle correction for near work.

Objective: Our study aims to compare the changes in amplitude of accommodation before and following cataract surgery, using the two most currently popular techniques of cataract surgery ─ Phacoemulsification and Manual small incision cataract surgery (MSICS). The parameters studied here may have a bearing on the visual outcome.

Methodology: Tertiary hospital-based, prospective observational study. NPA was recorded (cm) using the RAF Near Point Rule (RNPR) with the full distance correction in place by a designated trained optometrist. AA was determined as the reciprocal of NPA (metres). Parameters were measured pre-operatively, and further at 1, and 3 months post-operatively. Sample size was calculated as 120. Data were analyzed using STATA 13.1 I/C software. Data were summarized using mean along with standard deviation for continuous variables, and frequency along with percentage for categorical variables. Independent t-test and Chi-square test were used to compare baseline characteristics for continuous and categorical variables.

Results: There was an increase in AA in patients after cataract surgery both in the whole group and sub-groups for MSICS and Phacoemulsification. The AA was found to be significantly higher in the Phaco group pre-operatively compared to MSICS, but this difference was not seen post-operatively. Between the two subgroups of MSICS and Phacoemulsification, as well as overall, the increase in AA was found to be statistically significant at post-op 1 month ($p = 0.000$) and at 3 months ($p = 0.000$), compared to pre-op. The change in AA was found to be statistically significant ($p = 0.006$) pre-operatively between MSICS and Phaco groups, but not post-operatively. Negative correlation was noted between AA and the near add prescribed pre-operatively, as well as at post-operatively 1 month and at 3 months, in both MSICS and Phacoemulsification; this was found to be statistically significant ($p < 0.05$).

Conclusions: 1) Amplitude of accommodation increased after cataract surgery and PCIOL implantation. The difference in amplitude of accommodation noted pre-operatively between MSICS and Phacoemulsification was eliminated post-operatively. 2) Negative correlation between amplitude of accommodation and the near add prescribed was noted pre-operatively, as well as at post-operatively 1 month and at 3 months, in both MSICS and Phacoemulsification.

Keywords: Near point of accommodation, RAF near point rule, Amplitude of accommodation, Manual small incision cataract surgery, Phacoemulsification

Introduction

Cataract is considered to be the most common cause of age-related visual decline globally, accounting for nearly 50% of preventable blindness.[1] The overall prevalence of cataract varies from 1–4% of the population. There has been tremendous advancement and refinement in the field of cataract surgery over the past two decades.[2,3] Till 1980s, Intra capsular cataract extraction (ICCE) was widely practiced in which the entire natural crystalline lens, including the posterior capsule was removed as a single unit by disrupting the zonular fibres, without posterior chamber intraocular lens (PCIOL) implantation, leaving the eye aphakic.[4,5]

Visual rehabilitation was done using aphakic glasses or contact lens.[7,8] This technique is no longer used because of high rate of post-operative complications like vitreous loss, retinal detachment, astigmatism, and cystoid macular edema. Since the 1990s, ICCE has been largely

replaced by Extra capsular cataract surgery (ECCE), in which an opening (capsulotomy) is made in the anterior lens capsule, cataractous lens nucleus is removed and the entire cortical matter is aspirated leaving the posterior capsule and the supporting zonular apparatus intact.[9,11] This method facilitates implantation of PCIOL within the capsular bag, and is associated with relatively lower incidence of complications compared to ICCE. Different methods of ECCE include

1. Conventional ECCE (using sutures)
2. Manual small-incision cataract surgery (MSICS) – most often suture less, with implantation of a rigid PCIOL
3. Phacoemulsification (Phaco) ─ this is the most recent and advanced form of cataract surgery, wherein the nucleus is emulsified into tiny fragments using ultrasound energy, and generates vacuum for aspirating the cortex, followed by implantation of a foldable PCIOL within the capsular bag.[12,13]

The objective of modern cataract surgery is not only to execute a safe and excellent surgical procedure, but also to achieve post-operative emmetropia with increased uncorrected visual acuity for distance and near, especially with the use of multifocal and accommodating IOLs.[14,16] The introduction of refractive and diffractive multifocal IOLs is however, associated with a high incidence of undesirable untoward effects, such as increased halos and glare especially during night, and diminished contrast sensitivity.

Accommodation is the capacity of the eye to change the refractive power of the lens in order to automatically focus on objects at various distances.[17]It is the ability of the human crystalline lens to change its shape in order to bring objects that are close to the eye into sharp focus. It is a physiological process in which the natural crystalline lens changes its dioptric power in order to change its focus from distance to near. It is measured in terms of the amplitude of accommodation (AA) using the unit dioptre (D). Near point of accommodation (NPA) refers to the minimum distance at which the eye can comfortably, distinctly and clearly focus on an object without strain; at this point the image of the object is accurately focused on the retina at full accommodation. NPA is calculated (cm) subjectively using the RAF Near Point Rule (RNPR).[18] Far point (FP) is the farthest point at which the eye can see objects clearly without strain; at this point the image of the object is accurately focused on the retina with accommodation completely relaxed. The distance between the near point (NP) and the far point is called the range of accommodation. The difference between the dioptric power (D), needed to focus at NP and focus at FP is called the amplitude of accommodation (AA). It represents the difference between the refracting power of the eye when fully accommodated and when it is completely relaxed. It is the amount of accommodation exerted to move the focus from the FP to the NP with the distance correction in place. It measures the extent to which objects close to the eye can be focused. AA is determined as the reciprocal of NPA (metres). It is maximum during childhood and decreases with advancing age.[19]

Helmholtz in the nineteenth century proposed that accommodation occurs due to contraction of the ciliary body with the consequent relaxation of the zonular fibres, connecting the ciliary body to the lens, thereby producing an increase in the radius of curvature of the crystalline lens.[20] The resultant increment in lens curvature increases the refractive index of the lens, so that the light rays from near objects are refracted toward each other to a greater extent and, converge on the fovea.

With ageing, there appears to be a significant increase in stiffening of the lens, leading to weakening of the accommodative process, resulting in progressive difficulty in performing near work. This slow, physiological, age-related, irreversible decrease in maximal accommodative amplitude causing difficulty in near work (i.e., recession of the NP) is referred to as presbyopia.[21] With the decrease in AA, near work becomes difficult at a normal working distance, resulting in symptoms of asthenopia. The onset of symptoms varies with the patient's preferred working distance, the nature of the close work and the length of time for which it is done. The effect of age on the onset and progression of presbyopic symptoms is well documented. However, the role of refractive error in the genesis of presbyopia is unclear.[22] Following cataract surgery, the PCIOL does not possess any power of accommodation and thus majority of pseudophakes have difficulty in near vision and require bifocal / progressive spectacle correction for near work.

Our study aims to compare the changes in Amplitude of accommodation before and following cataract surgery using the two most currently popular cataract surgical techniques of Phacoemulsification and MSICS. The parameters studied here has a bearing on the visual outcome.

Materials and Methods

Study Design: Tertiary hospital-based, prospective observational study.

Study Setting: Conducted in the Department of Ophthalmology, Christian Medical College (CMC), Vellore (Schell campus), Tamil Nadu, India.

Study Duration: From November 2015 to August 2016, after obtaining the ethical approval of the Institutional Review Board (IRB Ref no: 9351).

Patient selection: Consecutive patients coming for cataract surgery fulfilling the inclusion and exclusion criteria were invited for the study.

Inclusion Criteria

- All patients above 50 years of age with age-related (senile) cataract posted for cataract surgery and PCIOL implantation (fulfilling the eligibility criteria) residing within 30 Km from the Schell Eye Hospital, Department of Ophthalmology, Christian Medical College, Vellore, Tamil Nadu, India.
- All patients coming for cataract surgery with best corrected near visual acuity (BCNVA) better than N12.

Exclusion Criteria

- All outstation patients
- Those with BCNVA less than N12
- Those with any ocular pathologies like – corneal opacity, ocular surface abnormalities, pseudoexfoliation, glaucoma, chronic uveitis, phacodonesis, diabetic retinopathy, retinal detachment, inherited retinal degenerations, age–related macular degeneration, myopic degeneration, central serous chorioretinopathy, optic neuropathy.
- Patients with higher mental function abnormalities – Parkinsonism, Schizophrenia.
- Systemic diseases like Diabetes mellitus (DM), cardiovascular ailments, chronic kidney disease, liver disease, autoimmune diseases and malignancy.
- Patients with intra-operative complications – posterior capsular rent, surgical aphakia, iridodialysis, or ACIOL implantation.

Informed consent and recruitment

All patients fulfilling the pre-operative inclusion and exclusion criteria were provided with an information sheet (available in English / Tamil) describing the aim / methodology of the study. Participants were recruited

into the study only after obtaining their informed consent.

- The selected patients were subjected to a comprehensive ophthalmological examination, including slit-lamp bio microscopy, fundus examination and measurement of intraocular pressure (IOP) using Goldmann applanation tonometer (GAT) by the principal investigator (Fig. 1)

Fig. 1: Complete ophthalmological examination by principal investigator

Pre-operatively, the following tests were performed (by two designated trained optometrists) ─

1. Visual assessment (uncorrected / best corrected visual acuity for distance and near) ─ using Snellen chart.
2. Near point of accommodation (NPA) ─ using the RAF Near Point Rule (RNPR).

- Uncorrected distance visual acuity (UCDVA) was measured ─ using Snellen chart at a distance of 6 metres. Objective refraction was done using a streak retinoscope (Streak retinoscope, Heine, Germany) and refined with subjective refraction. The best corrected distance visual acuity (BCDVA) was documented. Visual acuity readings from the Snellen chart were converted to the log MAR scale. The uncorrected near visual acuity (UCNVA) and the best corrected near visual acuity (BCNVA) were recorded at a distance of 33 cm using the New Times Roman chart.

NPA was measured (cm) using the RNPR with the full distance correction in place. The RNPR was originally developed in the United Kingdom during the mid-1950s under the guidance of Air Vice-Marshall J. C. Neely, for screening and assessing the visual capabilities of US military aircrew and conscripts.(18) The RNPR consists of a rotating four-sided cubical drum held on a slider attached to a square–section metal rule 50 cm in length, marked on the top in cm.(23) Each of the 4 sides has different accommodative targets with black prints on a white background, which includes: a) a reduced Snellen chart, b) section of GPO telephone directory, c) Times Roman type face, and d) a dot on a vertical line (fixation target) ─ for measuring the near point of convergence (NPC). The cheek rest (made of plastic) is attached to one end of the rule. It has a V-shaped notch in the centre to fit the nose, thereby allowing the device to be comfortably placed on the patient's cheek, at the level of his/her inferior orbital margin (Fig. 2). The NPA was measured with the patient trying to read the letters on the lowest line (Times Roman type N12 line) on the target drum. Before recording the measurements, the patient was explained in detail regarding the procedure, and was instructed to focus only on the letters on the lowest line (N12). The RAF rule was slightly depressed at an angle of 4°, and the target was slowly slided forwards on the rule towards the patient at a constant rate of 1-2 cm/sec, from 50 cm to the point where the patient complained of the letters becoming slightly blurred (Fig. 3). Then it was slowly pushed back till the letters could just be clearly read. This point was considered as the NPA. The NPA was recorded in cm from the rule. If the NPA was beyond 50 cm, suitable corrective plus lenses were used to bring the NPA to 50 cm or closer. If corrective adds were used to bring the NPA to 50 cm or closer, the

actual AA was ascertained after deducting the power of the corrective lens used. The amplitude of accommodation (AA) was determined as the reciprocal of NPA in metres.

Detailed diagrammatic algorithm of the study

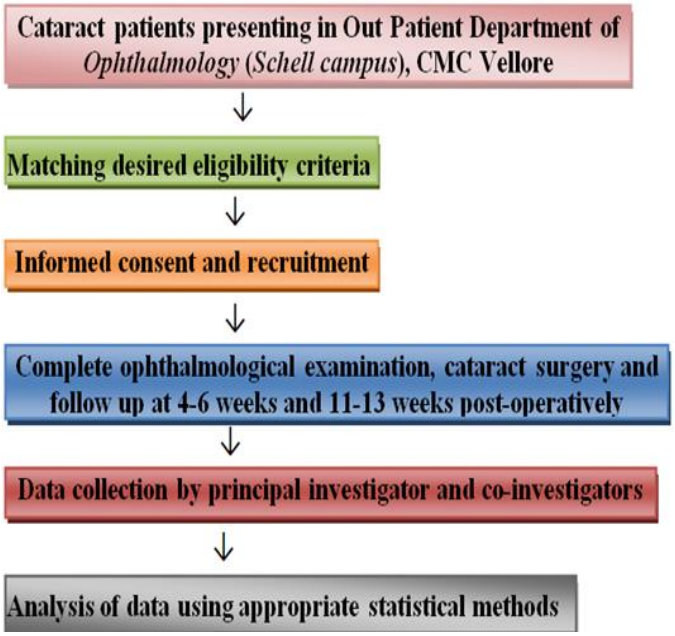

Fig. 2: RAF Near Point Rule (RNPR)

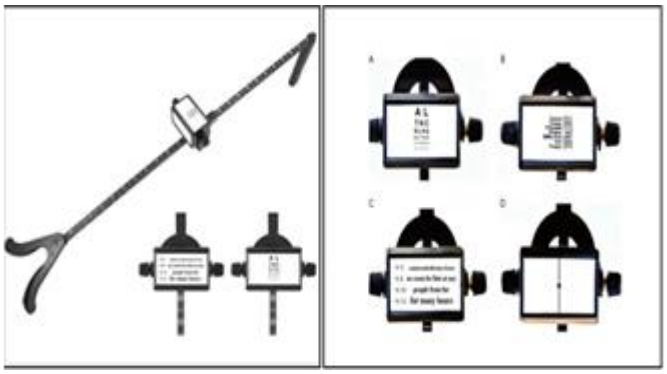

Fig. 3: Measurement of NPA by designated optometrist

Two types of cataract surgery (MSICS and Phacoemulsification) with PCIOL implantation were performed on the patients by multiple surgeons. The choice of surgery was based on multiple factors, which included the stage of cataract, hardness of nucleus (nuclear sclerosis), choice of IOL ─ rigid / foldable, and cost affordability. Those with intra - operative complications were excluded.

- Post-operatively, the same set of parameters (UCDVA / BCDVA / UCNVA / BCNVA, NPA and AA) were re-evaluated twice in exactly the same manner, once at 4-6 weeks and finally at 11-13 weeks by the same designated optometrists.
- All measurements were obtained under standardized environmental conditions in order to minimize variability.
- Ethical approval was obtained from the Institutional Review Board, and proper written consent was obtained from all participants prior to enrolment.

Sample size

The sample size was calculated based on difference in pupil diameter (PD) before cataract surgery and 1 month post-operatively, based on a study by Hayashi et al where, the average difference in PD between pre-op and 1month post-op was 0.26 with standard deviation of 0.8.(24)

From this, the required sample size to detect a difference of 0.26 units between pre-op and post-op pupil diameter was calculated as 120 with 80% power and 5% error.

A power analysis was done to check whether the available samples of 81 patients were sufficient, as the desired sample size was not achieved.

Mid-term analysis of our study population on 81 subjects showed that the average difference in PD between pre-op and 1 month post-op was found to be 0.26 with

standard deviation (SD) of 0.5. Power was calculated to be 98%. Since we were having difficulty recruiting the original sample size due to poorer BCNVA (worse than N12) than required in our patients, we recalculated the sample size requirements and found that 81 patients were sufficient to detect a significant difference. Data was collected from 98 patients for our study.

Data entry and analysis

The data was recorded in the clinical research form and was entered on the computer using Epi Data (Version 3.1) software. All the analyses were done using STATA 13.1 I/C software.

Quantitative variables and statistical methods

Two types of cataract surgery were performed on the recruited patients by multiple surgeons ─

1. MSICS, and
2. Phacoemulsification (Phaco)

Data were summarized using mean along with standard deviation for continuous variables, and frequency along with percentage for categorical variables. Independent t-test was used to compare baseline characteristics for continuous variables between the two types of cataract surgery. Chi-square test was used to test baseline characteristics of categorical variables between the 2 types of cataract surgery. Additionally, a comparative analysis was performed on the various parameters pre-operatively, and at 1 month and at 3 months post-operatively between MSICS and Phaco.

Repeated measures ANOVA was performed to look into the overall change in variables (AA) over time and the variation in the type of surgery over that time was also considered and reported.

Pearson correlation was used to check correlation between AA with other parameters like near add. Any differences in the variables showing a p value of less than 0.05 were considered to be statistically significant.

Potential confounders / suspected effect modifiers

The potential confounders and modifiers included systemic disorders like DM, the type of surgery done, type of PCIOL implanted and the operating surgeon (cataract surgery was performed by multiple surgeons). There was a possibility that the type of surgery (MSICS versus Phaco) could affect some of the parameters being studied.

Results

Over the study period from November 2015 to August 2016, a total of 109 patients fulfilling the eligibility criteria were invited for the study. Finally, 98 patients were recruited in our study, out of which only 74 patients completed the 3month post-operative follow up.

Demographic characteristics

- **Age distribution**
- The age of the recruited patients ranged from 50 to 78 years.
- The mean age was 64.15 ± 6.74 years.
- Table 1 shows the age distribution of the patients.

Table 1: Age distribution of patients

Variable	n	Mean	SD	Min	Median	Max
Age	98	64.15	6.74	50.00	64.00	78.00

- Age (years) SD − Standard deviation
- N − sample size Min − Minimum age
- Max − Maximum age

Gender distribution

Our study comprised of 49 males (50%) and 49 females (50%), with a sex ratio of 1:1.

Type of cataract surgery

24 patients (24.49%) were operated upon by MSICS and the remaining 74 (75.51%) underwent cataract surgery by Phacoemulsification.

Table 2 shows the percentage distribution of cataract surgery.

Table 2: Types of cataract surgery and gender distribution.

Surgery Type	n	Percentage	Males	Females
MSICS	24	24.49	12	12
PHACO	74	75.51	37	37
Total	98	100	49	49

- MSICS − Manual small incision cataract surgery
- PHACO − Phacoemulsification
- n – number of patients

Table 3 ─ shows the difference in AA before and after cataract surgery in the two subgroups of MSICS and Phaco, as well as overall. In all the 3 groups, the increase in AA was found to be statistically significant at post-op 1 month (p = 0.000) and at 3 months (p = 0.000), compared to pre-op. The change in AA was found to be statistically significant (p = 0.006) pre-operatively between MSICS and Phaco groups, but not post-operatively.

Table 3: Comparison of AA, pre-op and post-operatively at 1M and 3M, between MSICS and Phaco groups and also overall

	Pre-op	Post-op (1M)	Post-op (3M)
Overall	1.64 (± 0.59)	1.97(±0.46$^{\alpha}$	2.02 (± 0.42)$^{\beta}$
PHACO	1.70 (± 0.57)	1.98(±0.42$^{\alpha}$	2.03 (± 0.40)$^{\beta}$
MSICS	1.45 (± 0.63)	1.93(±0.56$^{\alpha}$	2.00 (± 0.50)$^{\beta}$

- AA – Amplitude of accommodation (dioptres)
- MSICS – Manual small incision cataract surgery
- PHACO – Phacoemulsification
- 1M – post-operative at 1 month
- 3M – post-operative at 3 months

α – statistically significant (p < 0.05) – at 1 month post-op versus pre-op

β – statistically significant (p < 0.05) – at 3 month post-op versus pre-op

► Table 4 ─ gives the difference in Near Add, before and after cataract surgery in the two subgroups of MSICS and Phaco, as well as overall. The decrease in Near Add was found to be statistically significant at post-op 1 month (p = 0.000) and at 3 months (p = 0.000), compared to pre-op in both MSICS and Phaco groups, as well as overall. Between the MSICS and Phaco subgroups, there was no statistically significant difference in Near add pre-operatively and post-operatively.

Table 4: Comparison of Near Add, pre-op and post-operatively at 1M and 3M, between MSICS and Phaco groups and also overall

	Pre-op	Post-op (1M)	Post-op (3M)
Overall	2.76 (± 0.25)	2.52(±0.20)$^{\alpha}$	2.48(±0.20)$^{\beta}$
PHACO	2.75 (± 0.26)	2.52(±0.21)$^{\alpha}$	2.49(±0.22)$^{\beta}$
MSICS	2.76 (± 0.25)	2.52(±0.16)$^{\alpha}$	2.46(±0.13)$^{\beta}$

MSICS – Manual small incision cataract surgery

Phaco – Phacoemulsification

1M – post-operative at 1 month

3M – post-operative at 3 months

α – statistically significant (p < 0.05) – at 1 month post-op versus pre-op

β – statistically significant (p < 0.05) – at 3 month post-op versus pre-op

Tables 5–7 ─ gives overall bird's eye view of the various parameters studied individually (MSICS / Phaco) in the entire study sample and in the subgroups of MSICS and Phaco. Results demonstrate that in all the 3 groups, the difference in the AA and Near add values were statistically significant (p = 0.000) postoperatively at 1 month and at 3 months, compared to pre-operatively.

Table 5: Overall comparison of AA and Near Add, between pre-op, at post-op 1M and 3M

Variables	Pre-op	Post-op(1M)	Post-op (3M)
AA	1.64(±0.59)	1.97(±0.46)$^{\alpha}$	2.02(± 0.42)$^{\beta}$
Near add	2.76(±0.25)	2.52(±0.20)$^{\alpha}$	2.48(± 0.20)$^{\beta}$

AA – Amplitude of accommodation (dioptres)

1M – post-operative at 1 month

3M – post-operative at 3 months

α – statistically significant (p < 0.05) – at 1-month post-op versus pre-op

β – statistically significant (p < 0.05) – at 3-month post-op versus pre-op

Table 6: Comparison of AA and Near Add, by MSICS pre-op, at post-op 1M and 3M

Variables	Pre-op	Post-op (1M)	Post-op(3M)
AA	1.45(±0.63)	1.93(±0.56)$^{\alpha}$	2.00(±0.50)$^{\beta}$
Near add	2.76(± 0.25)	2.52(±0.16)$^{\alpha}$	2.46(±0.13)$^{\beta}$

AA – Amplitude of accommodation (dioptres)

MSICS – Manual small incision cataract surgery

1M – post-operative at 1 month

3M – post-operative at 3 months

α ⁻ statistically significant (p < 0.05) – at 1-month post-op versus pre-op

β – statistically significant (p < 0.05) – at 3 month post-op versus pre-op

Table 7: Comparison of AA and Near Add, by Phaco pre-op, at post-op 1M and 3M

Variables	Pre-op	Post-op(1M)	Post-op (3M)
AA	1.70(±0.57)	1.98(±0.42)$^{\alpha}$	2.03(±0.40)$^{\beta}$
Near add	2.75(±0.26)	2.52(±0.21)$^{\alpha}$	2.49(±0.22)$^{\beta}$

AA – Amplitude of accommodation (dioptres)

Phaco – Phacoemulsification

1M – post-operative at 1 month

3M – post-operative at 3 months

α – statistically significant (p < 0.05) – at 1 month post-op versus pre-op

β – statistically significant (p < 0.05) – at 3 month post-op versus pre-op

Tables 8–10 ─ gives comparison between MSICS and Phaco for the various parameters, pre-operatively and post-operatively.

Table 8 ─ shows that between the MSICS and Phaco groups, the difference in the AA values were statistically significant (p = 0.000) pre-operatively in the Phaco group.

Table 8: Pre-op comparison ─ MSICS versus Phaco

Variables	MSICS	PHACO
AA	1.45 (± 0.63)	1.70 (± 0.57)$^{¥}$
Near add	2.76 (± 0.25)	2.75 (± 0.26)

AA – Amplitude of accommodation (dioptres)

MSICS – Manual small incision cataract surgery

Phaco – Phacoemulsification

¥ – statistically significant (p < 0.05) between the two groups pre-operatively

Table 9 ─ shows that at 1 month post-op between MSICS and Phaco, the difference in the AA and near add values were not statistically significant.

Table 9: Post-op 1 Month comparison – MSICS versus Phaco

Variables	MSICS	PHACO
AA	1.93 (± 0.56)	1.98 (± 0.42)
Near add	2.52 (± 0.16)	2.52 (± 0.21)

AA – Amplitude of accommodation (dioptres)

MSICS – Manual small incision cataract surgery

PHACO – Phacoemulsification

Table 10 – shows that at 3 months post-op between MSICS and Phaco, the difference in the AA and near add values were not statistically significant.

Table 10: Post-op 3 Month comparison – MSICS versus Phaco

Variables	MSICS	PHACO
AA	2.00 (± 0.50)	2.03 (± 0.40)
Near add	2.46 (± 0.13)	2.49 (± 0.22)

AA – Amplitude of accommodation (dioptres)

MSICS – Manual small incision cataract surgery

PHACO – Phacoemulsification

Table 11 – shows the correlation between AA and Near Add, pre-operatively as well as post-operatively at 1 month and 3 months

Table 11: Correlation between AA and Near add

	Pre-operative (n = 98)		Post-op 1M (n = 98)		Post-op 3M (n = 74)	
Near Add	r	p value	r	p value	r	
	– 0.199	0.049*	– 0.229	0.024*	– 0.332	0.004*

AA – Amplitude of accommodation (dioptres)

1M – post-operative at 1 month

3M – post-operative at 3 months

r – correlation coefficient

n – sample size

*p < 0.05 (statistically significant)

The above table summarizes the correlation between AA and near add. There is a negative correlation, which is statistically significant at pre-op and at post-op 1 month and at 3 months.

Discussion

So much has been the refinement in cataract surgery over the past two decades, that it has progressed from a sight-restoring surgery to a vision-enhancing or refractive surgery.[14,16]

- This study was specially designed with the idea of studying the amplitude of accommodation (AA) in patients before and after cataract surgery. This can be difficult as patients with senile cataract frequently have substantial impairment in near vision, which significantly impacts accurate near vision assessment prior to cataract surgery. With drastic improvements of cataract surgical outcomes, in recent times patients are operated much earlier than before. So we decided to recruit patients with near vision better than N12, so that NPA can be recorded on the RNPR with letter sizes not very different from the normal near N6 letter size. The problem with this was that the number of patients we could recruit was lower than we anticipated. We had to redo a sample size calculation based on our own patients studied. Since there was a bias towards doing Phacoemulsification for more immature cataracts, our sample was biased towards having more patients undergoing Phacoemulsifiation rather than MSICS.
- It has long been documented that some aphakic patients while wearing aphakic glasses with only their distance correction have reasonably good near vision; this phenomenon has been called apparent accommodation.[25,26] Following cataract surgery, the PCIOL does not possess any power of accommodation and thus, pseudophakes have difficulty in near vision

and require bifocal / progressive correction for near work. The power of the prescribed spectacles depends on the astigmatism induced by the incision, the power of the PCIOL implanted, the effective lens position (ciliary sulcus / capsular bag) and the visual needs of the particular patient (reading distance).

Pseudo-accommodation is a static optical phenomenon that does not involve the ciliary muscles altering the lens shape; it is the potential of certain pseudophakic eyes to sustain a reasonably good amount of clear near vision with only distance correction in place, following cataract surgery with monofocal PCIOL implantation.[27] It occurs possibly due to an increase in depth of focus due to a post-operative constricted pupil or induced myopic astigmatism, resulting in reasonably good distance and near visual acuity without near spectacle correction.[28] After cataract surgery, an increase in depth of focus due to a small pupil or myopic astigmatism is observed in some patients; this may result in good distance and near visual acuity without correction.[27,28] A study done by Verzella et al. revealed that low against-the-rule simple myopic astigmatism can often offer pseudophakic patients a rewarding independence from glasses both for distant and near vision.[29] A study was done by Nakazawa et al. to measure the pseudo-accommodation in 42 pseudophakic eyes after implantation of PCIOLs.[27] The diameter of the pupil appeared to be the most important factor in pseudo-accommodation ─ the smaller the pupil, the greater the pseudo – accommodation. The authors found a statistically significant correlation between pseudo–accommodation and depth of field.[30] Various factors like astigmatism, forward movement of IOL due to the contraction of the ciliary body etc are thought to contribute to this phenomenon.

- We wanted to evaluate if this amplitude of pseudo-accommodation was related to the cataract surgery and PCIOL implantation, or was it related to factors in the eye in dependant of this. It is for this reason we chose patients with good corrected near vision pre-operatively, so that one could compare with the good corrected post-op near visual acuity.
- In our study, we found that there was an increase in AA in patients after cataract surgery both in the whole group and sub-groups for MSICS and Phaco. The AA was found to be significantly higher in the Phaco group pre-operatively compared to MSICS, but this difference was not seen post-operatively. The increase in AA post-operatively seen in conjunction with the disappearance of difference in AA in the two sub-groups post-operatively, suggests that cataract surgery-related changes itself and to a greater extent some ocular factors may contribute to the AA. The cataract surgery-related changes could be better media clarity, corneal astigmatic changes, pupil diameter and anterior chamber depth changes. There seems to be a lot of scope to study the ocular factors contributing to AA.
- It was also surprising that we found only a small negative correlation between AA and the near add prescribed and this raises a lot of questions about what is being measured.
- Accommodation and AA is still an enigma and there is a lot of scope to explore its physiology to get better insights into near vision mechanisms so as to conquer a universal ageing phenomenon.

Conclusions

1. Amplitude of accommodation increased after cataract surgery and PCIOL implantation. The difference in amplitude of accommodation noted pre-operatively

between MSICS and Phacoemulsification was eliminated post-operatively.

2. Negative correlation between amplitude of accommodation and the near add prescribed was noted pre-operatively, as well as at post-op 1 month and at 3 months, in both MSICS and Phacoemulsification.

Limitations of Our Study

1) Though the initial requirement for our sample size was calculated at 120 subjects, reaching that target was difficult and we had to settle for the recalculated number of 81 patients. Finally, 98 patients were recruited in our study.

2) 25% of our patients could not be followed beyond one month due to time constraints ─ only 74 patients completed the 3month post-operative follow up.

3) The Phacoemulsification group had many more patients compared to the MSICS group, and this could have affected the sub-group analysis.

4) Some of the sub-group analysis had low power as the study was not designed to look into that.

5) Amplitude of accommodation, as measured by RAF rule, is a subjective test, and the lack of complete objectivity can be criticised.

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