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Original Research Article

A Clinical Study to Evaluate Change in Anterior Chamber Angle Configuration after Phacoemulsification with Foldable Iol Implantation in Senile Cataract Measured by Anterior Segment Optical Coherence Tomography

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Abstract

Aim The aim of this study was to measure early changes in anterior chamber morphology, including depth and angle, after phacoemulsification and foldable intraocular lens (IOL) implantation using Anterior Segment Optical Coherence Tomography (AS-OCT).

Methods: A prospective observational study was conducted at the Outpatient Department of the Department of Ophthalmology, Govt. Medical College, Kota, Rajasthan, from December 2022 to May 2024. The study included 50 patients diagnosed with senile cataract who underwent phacoemulsification and foldable PCIOL implantation. Preoperative and postoperative evaluations, including ACD and ACA measurements using AS-OCT, were performed. Statistical analysis was carried out using paired t-tests and Tukey tests.

Results: The mean age of participants was 69 ± 2.91 years, with a higher incidence of cataract among females (68%). Significant increases were observed in both ACD and ACA after surgery. The mean ACD increased from 2.51 ± 0.19 mm preoperatively to 3.95 ± 0.21 mm postoperatively ($p < 0.05$). The mean nasal angle increased by 11.68° ($p < 0.05$) and the temporal angle by 10.74° ($p < 0.05$). These changes were consistent across different grades of nuclear sclerosis (NS) cataracts. Gender-based analysis revealed greater increases in ACD and ACA in females.

Conclusion: AS-OCT provides accurate, non-invasive imaging of anterior chamber parameters, showing significant increases in both ACD and ACA after cataract surgery. This tool plays a vital role in optimizing surgical outcomes by improving IOL placement and aiding in postoperative assessments, ultimately enhancing patient care.

Keywords: Anterior Segment Optical Coherence Tomography (AS-OCT), Cataract Surgery, Anterior Chamber Depth (ACD), Anterior Chamber Angle (ACA), Phacoemulsification.

Introduction

Cataract refers to the clouding or opacity of the normally transparent lens of the eye or its surrounding capsule, which prevents light from reaching the retina. This condition, which can result in blindness, affects individuals across all age groups, from infants to the elderly, with a higher prevalence in older populations. In India and other developing nations, senile cataract is the leading cause of reversible blindness. Each year, around 38 million people in India are affected by cataract-induced blindness. Common risk factors for developing cataract include tobacco smoking, hypertension, and diabetes. [1,2] Currently, no medical treatment or preventive measures exist for cataract, with surgery being the only effective option. [3] Over time, cataract extraction techniques have evolved, from Extra Capsular Cataract Extraction (ECCE) to Small Incision Cataract Surgery (SICS) and Phacoemulsification, reducing incision size and enhancing visual rehabilitation. [4] Despite the availability of safe cataract surgeries in India, the number of cases continues to rise due to a backlog of patients and increased life expectancy. [5]

Ocular parameters like anterior chamber depth and angle are crucial in diagnosing and managing conditions such as cataract and glaucoma. [6]Traditionally, slit lamps were used to assess the

anterior segment, with Van Herick grading and gonioscopy as common methods. [7] Today, advanced imaging techniques like ultrasound biomicroscopy (UBM), Pentacam, Orbscan, and anterior segment optical coherence tomography (AS-OCT) are used for more detailed evaluation. [8-10]

AS-OCT is a non-invasive imaging technique that provides high-quality, quick assessments of the anterior segment, including the irido-corneal angle and anterior chamber. Although AS-OCT's role in cataract surgery is relatively new, studies have shown that phacoemulsification leads to a deepening of the anterior chamber and widening of the anterior chamber angle, benefiting patients with Primary Angle Closure Glaucoma (PACG) and Primary Open Angle Glaucoma (POAG). [11] This study aims to evaluate changes in the anterior chamber angle and depth after phacoemulsification cataract surgery and PCIOL implantation using AS-OCT.

Materials and Methods

The study was conducted at the Outpatient Department of the Department of Ophthalmology, Govt. Medical College and associated hospitals, Kota, Rajasthan, over a period of 18 months from December 2022 to May 2024. This was a prospective observational study that included 50 patients diagnosed with cataract who attended the outpatient clinics. Eligibility for the study was assessed based on a dilated slit lamp examination as part of their routine clinical assessment.

Inclusion criteria included patients with senile cataracts, normal intraocular pressure (IOP), normal anterior chamber depth, and postoperative clear corneas. Exclusion criteria included patients with complicated cataracts, previous intraocular surgery, corneal diseases such as edema or dystrophy, intraoperative complications like posterior capsule rupture, anterior segment pathology other than cataract, and those with glaucoma or ocular hypertension at the time of surgery. Written informed consent was obtained from all participants, and a detailed history was recorded, including personal details, presenting symptoms, and associated conditions. A general and systemic examination was conducted, followed by a comprehensive preoperative ocular evaluation. Visual acuity was assessed using Snellen's chart, with best corrected visual acuity (BCVA) documented. Intraocular pressure was measured by Goldman applanation tonometry, and a slit lamp examination was performed to assess the anterior segment and grade the cataract. A detailed fundus examination was conducted using an indirect ophthalmoscope, and images of the anterior segment were captured using Zeiss Cirrus HD-OCT 500 to measure anterior chamber depth.

For assessing the anterior chamber angle (ACA), measurements were taken using the Angle Tool in the Anterior Chamber Analysis screen. The anterior chamber depth (ACD) was measured by positioning the ACD Tool from the corneal endothelium to the anterior pole of the lens or IOL. The surgical procedure involved phacoemulsification and foldable PCIOL implantation under local anesthesia, with pupil dilation using tropicamide (0.8%) and phenylephrine (5%). Postoperative care included standard medications for two weeks, consisting of steroid and antibiotic drops. Two weeks after surgery, AS-OCT was repeated using the same parameters as preoperatively. Statistical analysis was performed using SPSS version 12, with paired t-tests used to compare preoperative and postoperative measurements of the angle and ACD, and Tukey tests to compare different grades of cataract and preoperative values between males and females. A p-value of <0.05 was considered statistically significant.

Results

The study included 50 patients, with a majority (76%) in the age group of 61-70 years, followed by 14% in the 71-80 years group, and 10% in the 51-60 years group. The mean age of the participants was 69 ± 2.91 years. In terms of sex distribution, 68% of the patients were female, while 32% were male. Regarding the lens grading, most patients (56%) were classified as having NS Grade II cataract, 40% had NS Grade III, and 4% were graded as NS Grade IV. The intraocular pressure (IOP) in the entire cohort had a mean value of 14.8 ± 3.07 mmHg. Breaking it down by IMSC grading, the mean IOP for patients with NS Grade II cataract was 15 ± 3.6 mmHg, for NS Grade III it was 14.7 ± 0.69 mmHg, and for NS Grade IV, it was 15.0 mmHg.

Table 1: Changes in Anterior Chamber Depth and Angle Before and After Cataract Surgery

Variable	Pre operative (Mean ± SD)	Post-operative (Mean ± SD)	Mean Difference	P-value
Anterior Chamber Depth (ACD)	2.51 ± 0.19	3.95 ± 0.21	1.41	0.00
Changes in ACD According to NS Grading				
NS Grade II	2.52 ± 0.19	3.90 ± 0.20	1.38	0.00
NS Grade III	2.53 ± 0.18	4.00 ± 0.22	1.47	0.00
NS Grade IV	2.09 ± 0.13	3.80 ± 0.00	1.71	0.00
Anterior Chamber Angle (ACA)				
Nasal Angle (in degrees)	22.66 ± 1.46	34.34 ± 1.22	11.68	0.00
Temporal Angle (in degrees)	25.22 ± 2.00	35.96 ± 1.19	10.74	0.00
Changes in Nasal Angle According to NS Grading				
NS Grade II	22.96 ± 1.07	34.07 ± 1.21	11.10	0.00
NS Grade III	22.50 ± 1.73	34.70 ± 1.14	12.20	0.00
NS Grade IV	20.00	34.50 ± 0.70	14.50	0.05
Changes in Temporal Angle According to NS Grading				
NS Grade II	25.53 ± 2.11	35.75 ± 1.20	10.21	0.00
NS Grade III	25.20 ± 1.60	36.35 ± 1.08	11.15	0.00
NS Grade IV	21.00	35.00	14.00	0.05

Table shows the changes in both anterior chamber depth (ACD) and anterior chamber angle (ACA) before and after cataract surgery. The values of ACD significantly increased from preoperative to postoperative measurements, with a mean difference of 1.41 mm across all cataract grades (P-value = 0.000). When analyzed according to cataract grading, patients with NS Grade II showed an increase of 1.38 mm in ACD (P-value = 0.000), while those with NS Grade III and NS Grade IV showed increases of 1.47 mm and 1.71 mm, respectively, with all differences being statistically significant (P-value = 0.000 for Grade II and III; P-value = 0.000 for Grade IV). Regarding the ACA, both nasal and temporal angles increased significantly after cataract surgery. The nasal angle showed a mean increase of 11.68 degrees (P-value = 0.000), and the temporal angle increased by 10.74 degrees (P-value = 0.000).

When categorized by NS grading, significant increases were also noted in the nasal and temporal angles across all grades. In NS Grade II, the nasal angle increased by 11.10 degrees, while the temporal angle increased by 10.21 degrees (both P-values = 0.000). In NS Grade III, the nasal angle increased by 12.20 degrees, and the temporal angle by 11.15 degrees (both P-values = 0.000). For NS Grade IV, the nasal angle increased by 14.50 degrees (P-value = 0.05), while the temporal angle increased by 14.00 degrees (P-value = 0.05), which is statistically significant for both angles.

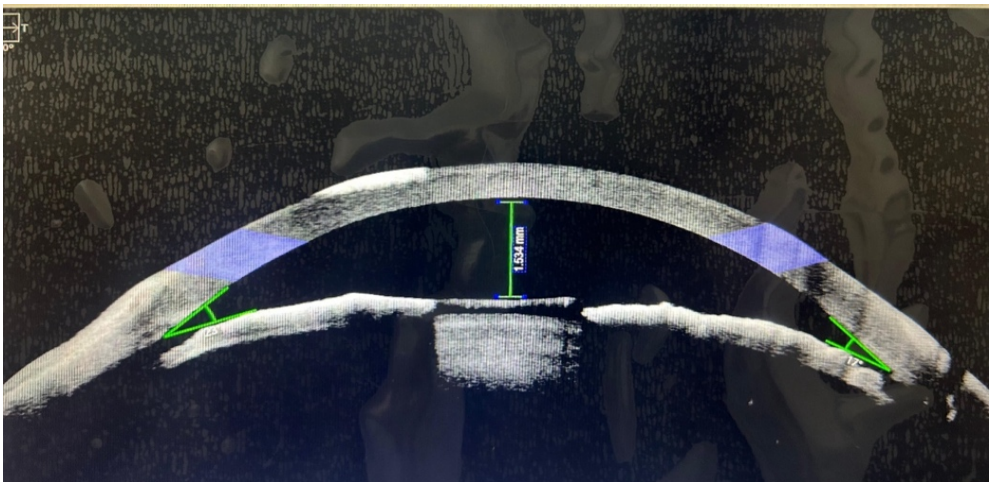

Figure 1: AS- OCT Image showing Nasal and Temporal Anterior chamber angle and Anterior Chamber Depth in pre op patient.

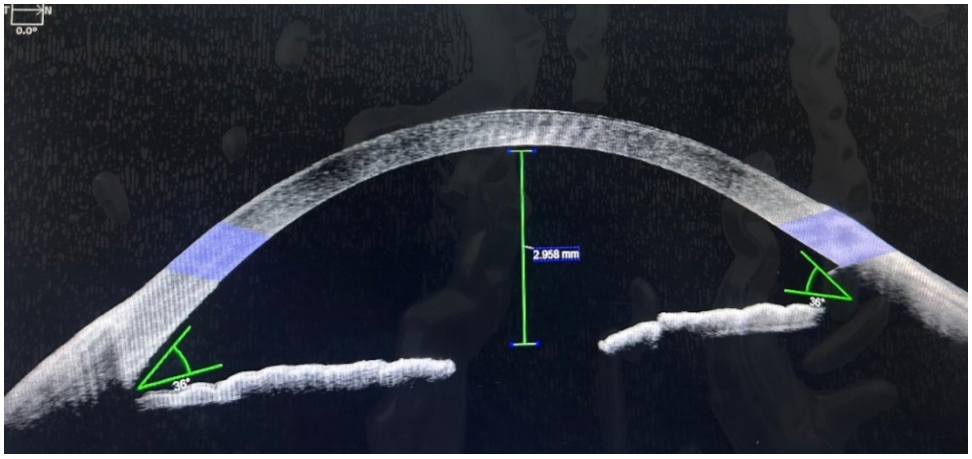

Figure 2: AS-OCT Image showing Nasal and Temporal Anterior chamber angle and Anterior Chamber Depth in post op patient

Discussion

Anterior Segment Optical Coherence Tomography (AS-OCT) is a cutting-edge, light-based imaging system that rapidly captures high-resolution images, offering exceptional clarity and detail. Its non-contact nature ensures a comfortable experience for patients, allowing quick image acquisition while they remain seated, without any physical contact that could cause discomfort. This design also eliminates the risk of mechanical distortion of the angle, ensuring accurate and reliable imaging results. Furthermore, AS-OCT supports comprehensive quantitative and dynamic data analysis, which is characterized by high reproducibility and repeatability, making it an invaluable tool in clinical practice.

This prospective observational study involves 50 subjects, primarily aimed at assessing changes in anterior chamber angle configuration following phacoemulsification and the implantation of foldable intraocular lenses (IOLs) in patients with senile cataract. The secondary objective was to evaluate changes in anterior chamber depth after cataract surgery and foldable IOL implantation in the same group. By utilizing AS-OCT, the study aims to provide detailed insights into the anatomical changes occurring post-surgery, thereby contributing to improved surgical outcomes and patient care.

The mean age of the patients in our study was 69 ± 2.91 years. Most patients (76%) were in the 61-70 age group, which is a common range for cataract development due to age-related changes in the eye's lens. Additionally, 14% were in the 71-80 age group, demonstrating that cataracts remain prevalent as individuals age. The remaining 10% were aged between 51-60, further highlighting that cataracts predominantly affect older adults.

In comparison, Anand Aggarwal et al.[12] (2022) found a mean age of 61.75 years in their study, with 15.5% of patients in the 35-50 age group, 33.5% in the 51-60 group, 34.5% in the 61-70 group, and 16.5% in the 71-85 group. Similarly, Varghese VAM et al. [13] (2018) reported a mean age of 59.35 ± 9.38 years (range 25–82 years).

Our study also found a higher incidence of cataract among women, with 68% of patients being female compared to 32% male . This finding aligns with the research of Kim et al. [14] (2011), who also reported a higher incidence of cataracts among women. This is consistent with existing studies suggesting that women are more prone to cataracts, potentially due to hormonal differences. Zetterberg et al. [15] (2014) proposed that the decline in estrogen levels during menopause may increase the risk of cataracts, as estrogen is believed to have protective effects, such as antioxidative properties, which can contribute to a longer lifespan in women. Other studies have shown that estrogen helps protect against oxidative stress, a key factor in cataract development. In contrast, Varghese VAM et al. [13] (2018) found a male-to-female ratio of 1.2:1, and Lee et al. [16] (2011) reported a higher incidence of cataracts among men, suggesting that environmental factors, such as UV exposure, smoking, and occupational hazards, may also contribute to cataract development.

Anterior chamber depth (ACD) refers to the distance between the posterior surface of the cornea and the anterior surface of the lens, which is crucial for determining the axial position of the IOL after surgery. In our study, the mean ACD was 2.51 ± 0.19 mm preoperatively, and increased significantly to 3.95 ± 0.21 mm two weeks postoperatively, with a mean difference of 1.41 mm ($P < 0.05$). This finding is similar to the results of Kim et al. [14](2011), who reported a mean preoperative ACD of 2.75 ± 0.43 mm, which increased to 4.14 ± 0.31 mm two days after surgery, representing a 50.5% deepening ($P < 0.001$). These results emphasize how phacoemulsification surgery with posterior chamber IOL implantation significantly deepens

the ACD, potentially reducing intraocular pressure (IOP).

We also assessed changes in ACD before and after cataract surgery, categorized by gender. In males, the mean preoperative ACD was 2.55 ± 0.19 mm, which increased to 3.96 ± 0.18 mm postoperatively, a mean difference of 1.40 mm. In females, the mean preoperative ACD was slightly lower at 2.49 ± 0.21 mm, increasing to 3.94 ± 0.22 mm post-surgery, with a mean difference of 1.44 mm. These changes were statistically significant (P = 0.000), with a slightly greater increase in ACD observed in females. This supports findings from Seda Ghat et al. [17] (2022), who reported a higher ACD in men compared to women preoperatively (2.93 ± 0.45 mm vs. 2.82 ± 0.42 mm, P = 0.002). Similarly, Hoffer et al. [18] (2017) found a mean ACD of 3.15 mm in males and 2.99 mm in females.

Our study also analyzed ACD changes according to nuclear sclerosis (NS) grading .In Grade II, the mean preoperative ACD was 2.52 ± 0.19 mm, which increased to 3.90 ± 0.20 mm postoperatively (P < 0.05). In Grade III, the ACD increased from 2.53 ± 0.18 mm to 4.00 ± 0.22 mm (P < 0.05). In Grade IV, the preoperative ACD was 2.09 ± 0.13 mm, which significantly increased to 3.80 ± 0.00 mm post-surgery (P < 0.05). These findings highlight that cataract surgery significantly increases ACD across various NS grades, contributing to the restoration of normal anatomical parameters and potentially improving visual outcomes and IOP regulation.

Additionally, we examined changes in the anterior chamber angle (ACA) after phacoemulsification surgery and IOL implantation using SD-ASOCT. The mean nasal angle increased from 22.66 ± 1.46° preoperatively to 34.34 ± 1.22° postoperatively, with a mean difference of 11.68° (P < 0.05). The temporal angle increased from 25.22 ± 2.00° to 35.96 ± 1.19°, with a mean difference of 10.74° (P < 0.05).

We also assessed changes in nasal angle by NS grading. In Grade II, the nasal angle increased from 22.96 ± 1.07° to 34.07 ± 1.21° (P < 0.05). In Grade III, the nasal angle increased from 22.50 ± 1.73° to 34.70 ± 1.14° (P < 0.05). In Grade IV, the nasal angle increased from 20.00° to 34.50 ± 0.70° (P < 0.05). Although changes in nasal angle were statistically significant, they were not correlated with the degree of nuclear sclerosis.

In evaluating gender-based differences, the mean preoperative nasal angle for males was 23.31° (SD = 1.49°), increasing to 34.06° (SD = 1.10°) post-surgery, with a mean difference of 10.7°. For females, the preoperative nasal angle was 22.35° (SD = 1.36°), which increased to 34.47° (SD = 1.23°) postoperatively, with a mean difference of 12.11°. Both gender-specific changes were statistically significant (P = 0.000), with females showing a slightly greater increase in nasal angle.

Similarly, for temporal angle ,males had a preoperative mean of 25.31° (SD = 2.18°), which increased to 33.50° (SD = 9.02°) post-surgery, with a mean difference of 8.18°. Females showed a preoperative mean of 25.17° (SD = 2.03°), which rose to 36.08° (SD = 1.13°), with a mean difference of 10.91°. These changes were statistically significant (P = 0.000), with a greater increase in temporal angle observed in females.

The results of this study align with those of Ghyadg et al. [19] (2019) and Kasai et al.[20] (2015), who also found significant increases in both nasal and temporal angles after cataract surgery. AS-OCT proves to be a valuable tool for evaluating and quantifying anterior segment changes post-surgery, providing detailed insights that contribute to improved surgical outcomes and patient care.

Conclusion

AS-OCT is a non-invasive, non-contact imaging technique that is increasingly valuable in cataract surgery. It offers precise measurements of the anterior chamber depth and angle, which are essential for preoperative planning, intraoperative guidance, and postoperative assessment. AS-OCT improves surgical precision, ensures correct IOL placement, and helps identify potential complications early, thus enhancing patient outcomes. Its high resolution, low variability, and non-contact nature make it a crucial tool for both patient safety and improved surgical results.

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