RESEARCH ARTICLE

# Change in anterior chamber depth before and after phacoemulsification in eyes with a short axial length-a quasi-experimental trial

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## Abstract

**Objective:** To determine changes in anterior chamber depth following phacoemulsification in eyes with a short axial length.

**Method:** The quasi-experimental study was conducted at the Department of Ophthalmology and Visual Sciences, Aga Khan University Hospital, Karachi, from May 26, 2023, to October 31, 2024, and comprised cataract patients aged 30-70 years with axial length<22mm undergoing phacoemulsification. Preoperative and postoperative anterior chamber depth measurements were recorded using an intraocular lens biometer. Postoperative assessments were done one week after the surgery. Data was analysed using R studio.

**Results:** Of the 20 patients with mean age 54.35±11.53 years, 14(70%) were females and 6(30%) were males. The total number of eyes studied was 36. Postoperatively, the mean anterior chamber depth increased significantly ($p$=0.001). A moderate positive correlation was found between preoperative and postoperative anterior chamber depth ($p$=0.049). Axial length showed a weak, non-significant positive correlation with preoperative anterior chamber depth ($r$=0.20, $p$=0.397) and a weak negative correlation with postoperative anterior chamber depth (r=-0.36, $p$=0.124). Age and gender were not significantly different with respect to change in anterior chamber depth ($p$>0.05). No intraoperative or postoperative complications were observed.

**Conclusion:** Phacoemulsification significantly increased anterior chamber depth in eyes with short axial lengths, confirming its anatomical and clinical benefits for cataract management.

**Keywords:** Anterior chamber depth, Biometry, Cataract, Phacoemulsification, Short axial length. (JPMA 76: 728; 2026)

**DOI: https://doi.org/10.47391/JPMA.30097**

## Introduction

Cataract, defined as the opacification of the natural crystalline lens, is the leading cause of reversible blindness and vision impairment worldwide, posing a significant global health challenge.1 It accounts for approximately 45% of global blindness, with higher incidence rate in low and middle income countries (LMICs) due to limited access to surgery.[1,2] Additionally, >90% of disability-adjusted life-years (DALYs) lost to cataracts are concentrated in LMICs.[3] In Pakistan, cataracts account for over half of the blindness cases, highlighting the urgent need for effective management strategies and equitable access to surgery.[4]

Currently, there are no established medical treatments or preventive strategies for cataracts, making surgical intervention the only viable option. Cataract surgery, which involves the removal of the opaque lens and implantation of an intraocular lens (IOL), is a highly effective procedure for restoring vision.[5] Over the years, surgical techniques have evolved significantly, from intracapsular cataract extraction (ICCE) to extracapsular cataract extraction (ECCE), and, more recently, to phacoemulsification.[5,6] Introduced by Dr Charles Kelman and Anton Banko in 1967, phacoemulsification has become the gold standard for cataract extraction due to its ability to provide better visual outcomes, reduced recovery times, and fewer complications compared to earlier methods.[5,7]

Phacoemulsification uses ultrasonic energy to fragment the cataractous lens, which is then aspirated, creating space for the insertion of a thinner IOL. In addition to its vision-restoring benefits, phacoemulsification induces significant anatomical changes in the anterior segment of the eye.[8,9] These include an increase in anterior chamber depth (ACD), widening of the anterior chamber angle (ACA), and an improvement in intraocular fluid dynamics, often leading to a reduction in intraocular pressure (IOP).[8,9] Such changes are particularly critical in eyes with short axial lengths (ALs), where the anterior chamber is naturally shallower, increasing the risk of complications like angle-closure glaucoma.[10]

Several studies have reported that in eyes with short ALs, the anterior chamber is naturally shallower compared to those with normal or longer AL.[9,10] For instance, Muzyka-Woźniak et al. reported a significantly greater deepening of the anterior chamber in such eyes, reflecting their

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**Submission completed:** 30-01-2025 **1st Revision received:** 16-05-2025

**Acceptance:** 31-12-2025 **Last Revision received:** 30-12-2025

distinct biomechanical response to lens extraction.[9] These findings emphasise the importance of understanding and accounting for unique anatomical features during surgical planning and follow-up care.[9]

To our knowledge, there is a lack of data from Pakistan specifically examining the impact of phacoemulsification on ACD in eyes with short AL. Considering the demographic and anatomical variability in populations, localised studies are essential to optimise surgical outcomes and minimise postoperative risks. The current study was planned to fill the gap in literature by evaluating changes in ACD before and after phacoemulsification in eyes with short ALs among patients at a tertiary care hospital in an urban centre.

## Subjects and Methods

The quasi-experimental study was conducted at the Department of Ophthalmology and Visual Sciences, Aga Khan University Hospital (AKUH), from May 26, 2023, to October 31, 2024. After approval from the institutional ethics review committee, the sample size was determined using Open Epi online calculator[11] based on previous data[9] with 90% power and 95% confidence level. The sample size was inflated to meet the assumptions of normal distribution and to account for 20% anticipated loss to follow-up. The sample was raised using non-probability consecutive sampling method. Those included were patients aged 30-70 years regardless of cataract stage and having short AL (<22mm), who planned to have phacoemulsification. Individuals with myopia, a history of previously diagnosed glaucoma, traumatic cataracts, a history of ocular surgery, and eyes with any complications during surgery necessitating a sulcus or anterior chamber intraocular lens (ACIOL) were excluded.

Prior to data-collection and the surgical procedure, written informed consent was obtained from all the patients, and the study followed the transparent reporting of evaluations with nonrandomized designs (TREND) guidelines for quasi-experimental study.[12]

All phacoemulsification procedures were conducted by a single experienced surgeon under topical anaesthesia. A 2.2mm clear corneal incision was made temporally to access the anterior chamber, accompanied by a paracentesis incision to facilitate instrument entry. The anterior lens capsule was stained with trypan blue dye to enhance visualisation, followed by thorough irrigation with balanced salt solution. A continuous curvilinear capsulorrhexis approximately 5.5mm in diameter was meticulously created under the protection of an ophthalmic viscosurgical device (OVD) to maintain ACD and protect intraocular structures. Hydrodissection was performed to separate the lens nucleus from the capsule, ensuring free rotation. Hydrodelineation was then carried out to delineate the central dense nucleus from the surrounding epinucleus. The nucleus was emulsified using an ultrasound phaco probe inserted through the main incision, employing a divide-and-conquer technique to fragment the nucleus for efficient removal. Residual cortical material was aspirated to ensure a clean capsular bag. The capsular bag was inflated with an OVD, and an injectable hydrophobic acrylic IOL was implanted within the bag, ensuring proper centration. The OVD was thoroughly removed from the anterior chamber and behind the IOL to prevent postoperative IOP spikes. The corneal incisions were hydrated with balanced salt solution to promote self-sealing, eliminating the need for sutures. Postoperatively, topical dexamethasone 0.1% and moxifloxacin drop was instilled to reduce the risk of postoperative infection and inflammation, and the operated eye was covered with a protective shield for 3-4 hours. The patients were instructed to return for a follow-up the next day and one-week post-surgery in the outpatient department (OPD).

Data regarding age, gender, AL and ACD was recorded using a predesigned proforma. The ACD in millimeters (mm) was measured using a biometer (Carl Zeiss Meditec AG 07745 Jena, Germany, IOLMaster 500) before phacoemulsification and one week after the procedure. To assess intra-observer variability, each observer conducted three consecutive measurements per session, and the mean value was calculated for analysis. Inter-observer variability was evaluated by having two independent observers perform measurements under identical conditions, with the average of their mean values used for final analysis. All measurements were performed under standard dim lighting conditions, without pupil dilation, and with patients seated using a chinrest and forehead strap. The change in ACD was determined by subtracting the preoperative ACD from the postoperative ACD.

Data was analysed using R Studio version 2024.09.1-394. For patients with data available for both eyes, the values of AL, preoperative ACD and postoperative ACD were averaged, and laterality was excluded to avoid duplication.

Data normality was assessed using the Shapiro-Wilk test, and it was found to be normally distributed ($p>0.05$). Data was reported as mean±standard deviation, median with interquartile range (IQR) or frequencies and percentages, as appropriate. Paired t-test was used to compare preoperative and postoperative ACD values. Pearson's correlation coefficients were used to evaluate the linear relationships of AL with both preoperative and postoperative ACD, as the assumptions for parametric correlation testing were met. The change in ACD was further stratified by age group and gender, and an independent samples t-test was applied to test for statistically significant differences between the groups. P<0.05 was considered statistically significant.

## Results

Of the 20 patients with mean age 54.35±11.53 years, 14(70%) were females and 6(30%) were males. The total number of eyes studied was 36. The median AL was 21.35mm (IQR: 20.54-21.69mm) (Table 1).

A significant increase in mean ACD was observed postoperatively 3.48±0.37mm compared to preoperative value 2.78±0.26 mm, with a mean paired difference of 0.70±0.35mm ($p$<0.001) (Figure 1).

Patients aged ≤45 years had a mean increase of 0.54±0.14mm, while those aged >45 years had a larger mean increase of 0.79±0.37mm ($p$=0.143). Male patients showed a mean change of 0.78±0.37mm compared to 0.67±0.34mm in females ($p$=0.532) (Table 2).

**Table-1:** Baseline characteristics (n=20).

| Characteristics | Mean±SD or Median (IQR) or n (%) |
|---|---|
| **Mean Age** (years) | 54.35±11.53 |
| **Gender** | |
| Female | 14 (70) |
| Male | 6 (30) |
| **AL** (mm) | 21.17±0.69 |

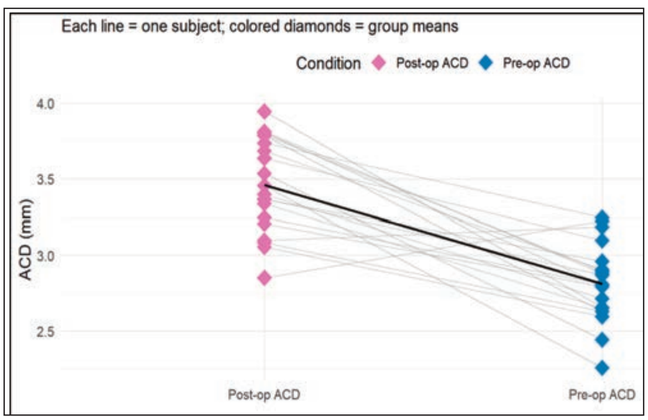


**Figure-1:** Comparison of preoperative and postoperative mean anterior chamber depth (ACD) (mm).

**Table-2:** Stratified analysis of change in ACD (mm) by age and gender.

| Characteristics | Change in ACD Mean±SD |
|---|---|
| Mean Age (years) | |
| ≤45 (n=3) | 0.54±0.14 |
| >45 (n=17) | 0.79±0.37 |
| *p*-value | 0.143 |
| Gender | |
| Male (n=6) | 0.78±0.37 |
| Female (n=14) | 0.67±0.34 |
| *p*-value | 0.532 |

ACD: Anterior chamber depth, SD: Standard deviation.

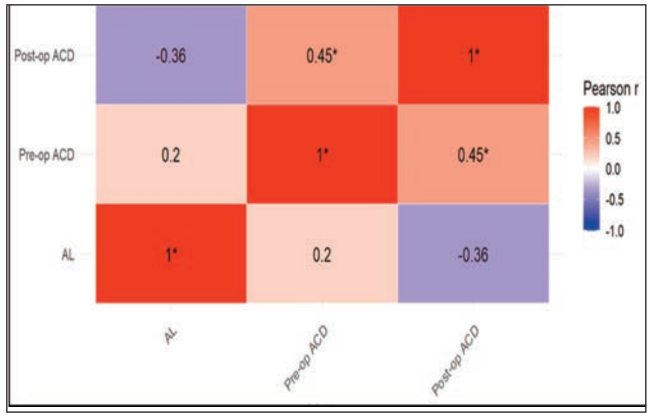


**Figure-2:** Correlation between preoperative and postoperative anterior chamber depth (ACD) and axial length (AL).

Preoperative and postoperative ACD values were moderately correlated ($r$=0.45, p=0.049). AL demonstrated a weak positive correlation with preoperative ACD ($r$=0.20, $p$=0.397) and a weak negative correlation with postoperative ACD ($r$=-0.36, $p$=0.124) (Figure 2).

No intraoperative or postoperative complications were observed.

## Discussion

Phacoemulsification is a well-known procedure in cataract surgery for improving visual acuity and significantly altering anterior segment anatomy, particularly by increasing ACD.[7] The current study aimed at evaluating changes in ACD before and after phacoemulsification in a cohort of Pakistani cataract patients, specifically those with shorter AL (<22mm), and to provide insights into its anatomical and clinical benefits for this population.

The median age of cataract patients was 54.35 years, which is consistent with literature, highlighting the high prevalence of cataracts in older age groups due to age-related changes.[13,14] The gender distribution in the study showed a higher percentage of females (70%), which was in line with earlier reports.[2,15,16] The female predominance may be attributed to genetic predispositions and hormonal influences affecting ocular morphology.[17] The mean AL was 21.35mm in the current study, which was consistent with earlier studies suggesting that similar surgical approaches may be effective for short eyes.[9,18] Additionally, most of the current patients had cataracts in both eyes, though literature has shown that laterality varies across populations and can affect both eyes simultaneously.[19]

A significant increase in mean ACD was observed postoperatively. The preoperative ACD was 2.78±0.26mm, while the postoperative ACD increased to 3.48±0.37mm, with a mean paired difference of 0.70±0.35mm (*p*=0.001). This is consistent with previous findings.[20-23] Furthermore, Ning et al. and Muzyka-Wozniak et al. indicated that short eyes experience a more pronounced ACD increase compared to long eyes, emphasising the distinct anatomical response of eyes with shorter ALs to phacoemulsification.[9,24] These findings collectively validate the anatomical benefits of the procedure and its impact on improving ACD, particularly in short eyes.

In the current study, preoperative ACD and AL did not significantly correlate with postoperative ACD, which is consistent with previous research indicating challenges of predicting postoperative ACD and IOL positioning based solely on preoperative measurements.[9] Studies have emphasised the difficulty in predicting outcomes in eyes with extreme ALs.[9] These findings highlight the importance of precise biometric evaluations and individualised surgical planning in cataract patients.

The current stratified analysis showed that patients aged >45 years had a greater mean ACD increase compared to those aged ≤45 years, though the difference was not statistically significant (*p*=0.143). Additionally, males had a mean ACD increase compared to females (*p*=0.532), again showing no significant difference. These findings are in line with literature.[22]

A key strength of the current study is its focus on patients with short ALs, an underrepresented group in literature, providing valuable insights into their anatomical and clinical outcomes following phacoemulsification. The use of the IOL Master 500, a gold standard for non-contact biometry, ensured precise and reproducible ACD measurements. Additionally, its dual measurement modes for simultaneous AL and keratometry readings optimised workflow efficiency, minimising measurement variability.[25,26] However, the current study has its limitations, including a small sample size, single-centre design, and short follow-up duration, which together restrict the generalisability of the findings and limit understanding of long-term outcomes. The exclusion criteria, such as prior myopia or glaucoma, further constrained the study's applicability to broader populations. Future research should incorporate multi-centre cohorts, extended follow-up, and broader demographic samples to validate the findings. Including comparisons of ACD measurements across multiple diagnostic devices, such as Pentacam and ultrasound biometry, could enhance reliability and address potential observer biases. Further studies should also explore the long-term implications of ACD changes, particularly in the context of preoperative and postoperative gonioscopy in patients with open-angle and angle-closure glaucoma mechanisms.

## Conclusion

Phacoemulsification significantly increased ACD in eyes with short AL, confirming its anatomical and clinical benefits for cataract management, and highlighting the importance of early surgical intervention and tailored approaches for short eyes.

**Acknowledgement:** We are grateful to Syeda Mahnoor Zehra Rizvi for editorial facilitation.

**Disclaimer:** None.

**Conflict of Interest:** None.

**Source of Funding:** None.

## References

1. Ahsan S, Memon MS, Bukhari S, Mahmood T, Fahim MF, Haseeb U, et al. Visual outcomes of cataract surgery: An observational study of ten years from a tertiary eye care hospital in Pakistan. Pak J Med Sci 2021;37:1775-81. doi: 10.12669/pjms.37.7.4428.
2. Fang R, Yu YF, Li EJ, Lv NX, Liu ZC, Zhou HG, et al. Global, regional, national burden and gender disparity of cataract: findings from the global burden of disease study 2019. BMC Public Health 2022;22:2068. doi: 10.1186/s12889-022-14491-0.
3. Jiang B, Wu T, Liu W, Liu G, Lu P. Changing Trends in the Global Burden of Cataract Over the Past 30 Years: Retrospective Data Analysis of the Global Burden of Disease Study 2019. JMIR Public Health Surveill 2023;9:e47349. doi: 10.2196/47349.
4. Malik M, Strang N, Campbell P, Jonuscheit S. Exploring eye care pathways, patient priorities and economics in Pakistan: A scoping review and expert consultation study with thematic analysis. Ophthalmic Physiol Opt 2022;42:694-716. doi: 10.1111/opo.12977.
5. Chen X, Xu J, Chen X, Yao K. Cataract: Advances in surgery and whether surgery remains the only treatment in future. Adv Ophthalmol Pract Res 2021;1:e100008. doi: 10.1016/j.aopr.2021.100008.
6. Atima MO, Idakwo U, Komolafe O, Shimizu E, Shintaro N, Balogun EO, et al. Long-Term Outcomes of Phacoemulsification Surgeries at ECWA Eye Hospital: A Prospective Clinical Cohort Study. J Ophthalmol 2024;2024:e2562064. doi: 10.1155/2024/2562064.
7. Benítez Martínez M, Baeza Moyano D, González-Lezcano RA. Phacoemulsification: Proposals for Improvement in Its Application. Healthcare (Basel) 2021;9:1603. doi: 10.3390/healthcare9111603.
8. Imtiaz HS, Malik IQ, Ali F. How Cataract Extraction Helps in Improving Aqueous Outflow?. Pak J Ophthalmol 2018;34:279-85.
9. Muzyka-Woźniak M, Ogar A. Anterior chamber depth and iris and lens position before and after phacoemulsification in eyes with a short or long axial length. J Cataract Refract Surg 2016;42:563-8. doi: 10.1016/j.jcrs.2015.12.050.
10. Khalid M, Ameen SS, Ayub N, Mehboob MA. Effects of anterior chamber depth and axial length on corneal endothelial cell density after phacoemulsification. Pak J Med Sci 2019;35:200-4. doi: 10.12669/pjms.35.1.92.
11. Dean AG, Sullivan KM, Soe MM. OpenEpi: Open Source Epidemiologic Statistics for Public Health, Version: 3.01. [Online] 2013 [Cited 2025 May 10]. Available from URL: https://www.openepi.com/Menu/OE_Menu.htm

12. Haynes AB, Haukoos JS, Dimick JB. TREND Reporting Guidelines for Nonrandomized/Quasi-Experimental Study Designs. JAMA Surg 2021;156:879-80. doi: 10.1001/jamasurg.2021.0552.
13. Hashemi H, Khabazkhoob M, Nabovati P, Ostadimoghaddam H, Shafaee S, Doostdar A, et al. The Prevalence of Age-Related Eye Disease in an Elderly Population. Ophthalmic Epidemiol 2017;24:222-8. doi: 10.1080/09286586.2016.1270335.
14. Jadoon Z, Shah SP, Bourne R, Dineen B, Khan MA, Gilbert CE, et al. Cataract prevalence, cataract surgical coverage and barriers to uptake of cataract surgical services in Pakistan: the Pakistan National Blindness and Visual Impairment Survey. Br J Ophthalmol 2007;91:1269-73. doi: 10.1136/bjo.2006.106914.
15. Lou L, Ye X, Xu P, Wang J, Xu Y, Jin K, et al. Association of Sex With the Global Burden of Cataract. JAMA Ophthalmol 2018;136:116-21. doi: 10.1001/jamaophthalmol.2017.5668.
16. Prasad M, Malhotra S, Kalaivani M, Vashist P, Gupta SK. Gender differences in blindness, cataract blindness and cataract surgical coverage in India: a systematic review and meta-analysis. Br J Ophthalmol 2020;104:220-4. doi: 10.1136/bjophthalmol-2018-313562.
17. Korpole NR, Kurada P, Korpole MR. Gender Difference in Ocular Diseases, Risk Factors and Management with Specific Reference to Role of Sex Steroid Hormones. J Midlife Health 2022;13:20-5. doi: 10.4103/jmh.jmh_28_22.
18. Yosar JC, Zagora SL, Grigg JR. Cataract Surgery in Short Eyes, Including Nanophthalmos: Visual Outcomes, Complications and Refractive Results. Clin Ophthalmol 2021;15:4543-51. doi: 10.2147/OPTH.S344465.
19. Chapter 11 - Cataract. In: Black GCM, Ashworth JL, Sergouniotis PI, eds. Clinical Ophthalmic Genetics and Genomics. New York, NY: Academic Press, 2022; pp 113-46. DOI: 10.1016/C2016-0-05218-X
20. Vu AT, Bui VA, Vu HL, Quyet D, Thai TV, Nga VT, et al. Evaluation of Anterior Chamber Depth and Anterior Chamber Angle Changing After Phacoemulsification in the Primary Angle Close Suspect Eyes. Open Access Maced J Med Sci 2019;7:4297-4300. doi: 10.3889/oamjms.2019.378.
21. Ifeanyi OC, Fortune BO, Eghosasere I. Comparative study between phacoemulsification and small incision cataract surgery on the axial length and anterior chamber depth. J Niger Optom Assoc 2024;26:13-20. doi: 10.4314/jnoa.v26i2.4.
22. Tayyab M, Abid A. Early Post-Operative Effect of Phacoemulsification on Anterior Chamber Depth and Intraocular Pressure in Patients with Cataract. Pak J Ophthalmol 2021;37:147-51. Doi: 10.36351/pjo.v37i2.1176.
23. Liu XQ, Zhu HY, Su J, Hao XJ. Effects of phacoemulsification on intraocular pressure and anterior chamber depth. Exp Ther Med 2013;5:507-10. doi: 10.3892/etm.2012.835.
24. Ning X, Yang Y, Yan H, Zhang J. Anterior chamber depth - a predictor of refractive outcomes after age-related cataract surgery. BMC Ophthalmol 2019;19:134. doi: 10.1186/s12886-019-1144-8.
25. Sung H, Ferlay J, Siegel RL, Laversanne M, Soerjomataram I, Jemal A, et al. Global Cancer Statistics 2020: GLOBOCAN Estimates of Incidence and Mortality Worldwide for 36 Cancers in 185 Countries. CA Cancer J Clin 2021;71:209-49. doi: 10.3322/caac.21660.
26. Gupta V, Pal H, Sawhney S, Aggarwal A, Vanathi M, Luthra G. Optimization of biometry for best refractive outcome in cataract surgery. Indian J Ophthalmol 20241;72:29-43. doi: 10.4103/IJO.IJO_1219_23.

**Author Contribution:**

**DM:** Concept, methodology, data analysis, project administration and final review.

**KA:** Methodology, final statistical analysis, results, data interpretation, writing, review, editing, supervision and final review.

**HIQ:** Methodology, project administration, data curation and final review.

**SAC:** Concept, formal analysis, supervision, project administration and final review.