Chattagram Maa-O-Shishu Hospital Medical College Journal
Volume 25, Issue 1, January 2026
https://doi.org/10.3329/cmoshmcj.v25i1.89967

Original Article

Changes of Central Corneal Thickness After Phacoemulsification

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Abstract

Background: *Preservation of corneal endothelial integrity is crucial for optimal visual recovery following phacoemulsification cataract surgery. Central Corneal Thickness (CCT) serves as an indirect indicator of postoperative endothelial function. The purpose of the study is to evaluate the changes in central corneal thickness before and after uneventful phacoemulsification among patients with age-related cataract.*

Materials and methods: *This prospective observational study included 49 patients underwent phacoemulsification at Chittagong Medical College Hospital from January 2021 to December 2021. CCT was measured preoperatively and on postoperative day 1, day 7 and day 30 using an ultrasound pachymeter. Visual status and postoperative complications were assessed. Data were analyzed using paired t-tests, with $p < 0.05$ considered statistically significant.*

Results: *The mean age of the patients was 57.37±10.62 years (Range: 51-75), with a slight male predominance (53.1%). Grade II cataracts were the most common (51.0%). The mean preoperative CCT was 538.12 ± 8.45 µm. Postoperative CCT increased significantly on day 1 (614.84 ± 12.56 µm) and day 7 (582.31 ± 14.20 µm) ($p < 0.001$). By day 30, CCT returned near baseline (539.94 ± 8.19 µm) with no significant difference from preoperative values ($p = 0.283$). Corneal edema occurred in 6 patients (12.2%); no cases of infection or posterior capsular rupture were recorded.*

Conclusion: *Phacoemulsification causes a transient increase in CCT during the early postoperative period, which typically resolves by 30 days, indicating preserved endothelial recovery.*

Key words: Cataract surgery; Central corneal thickness; Corneal edema; Phacoemulsification.

INTRODUCTION

Globally, cataracts are a major cause of blindness and visual impairment. It has been shown that 35.1 million out of 191 million persons with impaired vision worldwide suffer from cataracts, which account for 10.8 million of the 32.4 million blind people.[1] Cataract prevalence rises with age, from 3.9% in those aged 55–64 to 92.6% in people aged 80 and beyond.[2] One of the most frequent surgical operations carried out worldwide is cataract surgery, which has been estimated to happen at a rate of 4,000–10,000 per million in developed countries.[3]

Phacoemulsification (PHACO) or extra-capsular lens extraction [small-Incision Cataract Surgery (SICS)] with Intraocular Lens (IOL) implantation are two surgical techniques used to treat this age-related vision impairment.[4] One of the main objectives of phacoemulsification is the preservation of corneal endothelial function, which is crucial for preserving corneal transparency and, consequently, visual rehabilitation.The goal of cataract surgery is currently regarded as a refractive procedure, which is to attain a state of emmetropia, rather than only vision restoration.[5]

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Date of Submission : 06.11.2025
Date of Acceptance : 02.12.2025

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Corneal edema can occur due to endothelial damage during surgery. Normal vision requires normal endothelial cell structure and function. Corneal transparency is maintained by the corneal endothelium, the epithelium's barrier function and the stroma's special structural characteristics. Damage to endothelial cells causes the permeability of the endothelial cell layer to increase, overriding the action of the endothelial cell pump. Inability to maintain deturgescence causes the stroma to become thick, swollen and hazy, leading to vision loss.[6] Factors directly related to the patient (Low endothelial cell density, cataract grade, shallow anterior chamber depth) to the surgical procedure (Nucleus extraction method, effective power time of ultrasound for lens extraction, type of viscoelastic used, vitreous loss and rupture of the posterior capsule) or to intraocular lens implantation (Chronic iritis, secondary glaucoma, peripheral anterior synechiae, intraocular lens subluxation) are responsible for corneal swelling or oedema.[7] Therefore, because of endothelial pump failure, corneal edema occurs which manifests as increase in Central Corneal Thickness (CCT) value. Corneal edema is often a preventable or avoidable complication. Successful management relies on careful preoperative workup (To identify pre-existing risk factors) intraoperative precautions (Minimizing phaco time, using protective solutions) and vigilant postoperative care.[8]

Complications following phacoemulsification are systematically categorized into intraoperative and postoperative sequelae. Key intraoperative risks include Posterior Capsular Rupture (PCR) and related Vitreous Loss or Zonular Dialysis, alongside infrequent but seriousevents such as Iris Prolapse and Descemet's Membrane Detachment. Postoperative complications primarily involve Posterior Capsule Opacification (PCO) which is the most common long-term issue. More critical but less frequent postoperative events include Infection (Endophthalmitis) Retinal Detachment, Cystoid Macular Edema (CME) and transient conditions like Corneal Edema and Elevated Intraocular Pressure (IOP).[9] A recent study analyzing phacoemulsification surgeries found one PCR with Nucleus Drop and one Phacoemulsification Burn (at the wound).[10] These complications necessitate vigilance and standardized management protocols to optimize visual outcomes.

Corneal edema is a key factor that can delay postoperative visual recovery following cataract surgery. Evaluating changes in pachymetry before and after surgery provides valuable insight into the impact of phacoemulsification on corneal integrity. Therefore, assessing postoperative alterations in central corneal thickness is rational, as it may guide ophthalmologists in refining surgical techniques, optimizing instrumentation and improving postoperative care to reduce endothelial damage.

MATERIALS AND METHODS

This prospective observational study was conducted in the Department of Ophthalmology, Chittagong Medical College Hospital (CMCH) over one year from January 2021 to December 2021. Patients undergoing phacoemulsification for age-related cataract were recruited by convenient sampling. A total of 49 patients met the eligibility criteria.

Inclusion criteria were patients ≥50 years of age with Grade I–III age-related cataract. Exclusion criteria included Grade IV cataract, uncontrolled systemic disease, retinal pathology, active ocular infection and prior intraocular or corneal surgery.

After obtaining written informed consent, baseline demographic and clinical data were recorded. CCT was measured preoperatively and on postoperative day 1, day 7 and day 30 using an ultrasound pachymeter (Tomey Corporation, Japan). Visual acuity and postoperative complications were assessed during follow-up.

Data were collected on a structured form and analyzed using SPSS version 25. Quantitative variables were summarized as mean ± SD, and categorical data as percentages. Pre- and postoperative CCT values were compared using paired t-tests, with $p < 0.05$ considered statistically significant.

Ethical approval was obtained from the institutional ethics committee (Memo No. CMC/PG/2021/692 Date: 25/01/2021) and confidentiality was maintained throughout the study.

RESULTS

Table I Age and Gender distribution of study participants (n=49)

Variables (Unit)	Category	n (%)
Age (Years)	51-60 years	24 (49%)
	61-70 years	15 (30.6%)
	71 years & Above	10 (20.4%)
	Mean ± SD	57.37±10.62
	Range	51-75
Gender	Male	26 (53.1%)
	Female	23 (46.9%)

Data are expressed as frequency (Percentage) or mean ± SD (Range).

Table I shows, mean age of the patients was 57.37 years (Range: 51-75) with SD ±10.62 years. Male predominance 26 (53.1%) was observed.

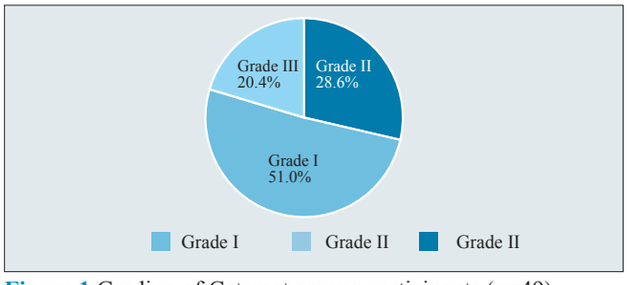

Figure 1 Grading of Cataract among participants (n=49)

Figure shows, Grade II was found among 25 (51.0%) and Grade I was found among 14 (28.6%) patients. Only 10 (20.4%) had Grade III cataract.

https://doi.org/10.3329/cmoshmcj.v25i1.89967 Volume 25, Issue 1, January 2026

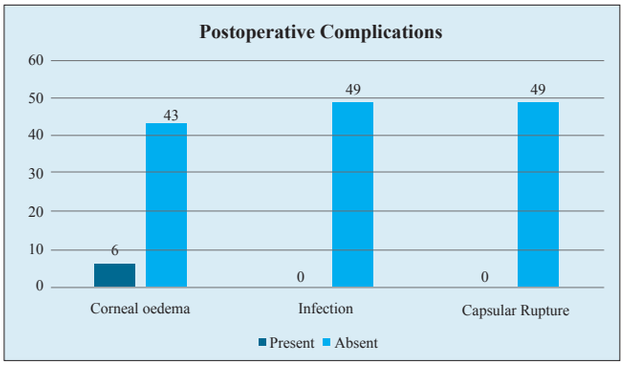

Figure 2 Post-Operative complications

Bar diagram shows post-operative complications. Out of total 49 patients, only 6 (12.2%) patients had corneal edema that increased the central corneal thickness. No patients had infection and capsule rupture.

Table II Association of Pre-operative and Post-operative Central Corneal thickness of the study patients (n=49)

CCT	Pre-operative	Post-operative		
		Day 1	Day 7	Day 30
Mean ± SD	538.12±8.450	614.84±12.557	582.31±14.200	539.94±8.189
Range	517-555	599-642	540-602	520-558
p value		<0.001*	<0.001*	0.283

Data are expressed as mean ± SD (Range), * = Highly significant, p value derived from paired t-test.

Table II shows association pre- and post-operative central corneal thickness of the patients. Pre-operative mean central corneal thickness was 538.12µm (range: 517-555) with SD ±8.450µm; post-operative mean central corneal thickness after day 1, 7 and 30 was 614.84µm (Range: 599-642), 582.31µm (Range: 540-602) 539.94µm (Range: 520-558) and SD ±12.557µm, ±14.200µm and ±8.189µm respectively. There was statistically highly significant difference between pre-operative values and values on post-operative day 1 and post-operative day 7 ($p < 0.001$). But there was no statistically significant difference between values prior to surgery and post-operative day 30 ($p = 0.283$).

DISCUSSION

In the present study mean ± SD age and sex distribution of the patients. Mean ± SD age of the patients was 57.37±10.62 (range: 31-75) years. Similar findings were observed in previous studies.[11] This age distribution is consistent with the well-documented prevalence of cataract increasing with advancing age due to cumulative lens protein changes and oxidative stress.[12] The majority of patients were between 51 to 60 years (49%) followed by 61 to 70 years (30.6%) highlighting the critical age range for cataract development and intervention. The relatively lower proportion of patients above 70 years may reflect delayed healthcare-seeking behavior or comorbidities that limit surgical eligibility in older age groups. Sex distribution showed a slight male predominance (53.1% male vs. 46.9% female), suggesting a marginally higher incidence or healthcare-seeking behavior among males in this sample. Globally, a higher cataract burden is linked to older age, females and lower socioeconomic status.[13]

Regarding cataract grading, Grade II cataracts were most common (51%), followed by Grade I (28.6%) and Grade III (20.4%). This distribution suggests that most patients sought care during the moderate stage of lens opacity, where visual impairment becomes more functionally significant. The lower proportion of Grade III cataract may indicate improved awareness, earlier detection, and expanded cataract surgery services in tertiary centers. Early-stage presentations are also advantageous, as surgical outcomes tend to be better in cases without advanced lens density or zonular compromise.

Regarding post-operative complications, only 6 (12.2%) patients had corneal edema. No patients had infection and capsule rupture. The fact that only 20.4% of our study had Grade III cataracts may partially account for the low rate of major complications observed. A higher cataract grade, particularly for Nuclear Sclerotic (NS) and brunescent cataracts (e.g. LOCS III Grade 4+) is generally associated with increased lens hardness, which necessitates higher Cumulative Dissipated Energy (CDE) during phacoemulsification.[14] Increased CDE and operative time can, in turn, lead to greater stress on the corneal endothelium and a subsequently higher risk of postoperative corneal edema.[7]

This study shows pre- and post-operative central corneal thickness of the patients. Pre-operative mean central corneal thickness was 538.12µm (Range: 517-555) with SD ±8.450µm, post-operative mean central corneal thickness after day 1, 7 and 30 was 614.84µm (Range: 599-642) 582.31µm (Range: 540-602) 539.94µm (Range: 520-558) and SD ±12.557µm, ±14.200µm and ±8.189µm respectively. Similar observation was found in most of previous studies. Deshpande et al. found, the preoperative value of mean CCT was 518.46, on day 7th was 533.78 and on day 30th was 524.9.[15] In their study by Bamdad et al. reported, the central corneal thickness increased significantly after surgery (From 530.47±2.60 to540.91±36.07).[11] The CCT measured with the mean value of 606.04 ± 6 m in postoperative day 1, on day 14, the CCT mean value was 553.81 ± 4 µm and over a period of 1 month, the CCT value mean value was 544 ± 2µm. It can be observed that the CCT measurement gradually decreases with time and returns to near-normal state on day 30.[16] This rapid resolution strongly suggests that the corneal endothelium's pump function remains robust, effectively managing the surgical insult. However, this finding underscores a critical clinical consideration: CCT measurements taken during the peak

https://doi.org/10.3329/cmoshmcj.v25i1.89967

edema phase in the first month will be falsely elevated, potentially leading to a systematic underestimation of true Intraocular Pressure (IOP). Therefore, for accurate long-term glaucoma risk assessment or planning for subsequent corneal procedures, the final stabilized CCT measurement should be delayed until the cornea has reached its resolved state, generally at or near 30 days post-operation.

The study shows association between pre and post-operative central corneal thickness of the patients. There was statistically highly significant difference between pre-operative values and values on post-operative day 1 and post-operative day 7 ($p<0.001$). On the other hand, there was no statistically significant difference between values prior to surgery and 30 days after surgery ($p= 0.283$). Similarity was found in previous study. On central corneal thickness comparison before and after surgery, thickness was 539.08+33.35 before surgery, while after surgery it was found 583.37+30.55 with significant difference p-value 0.01.[17] Deshpande et al. found, there was a statistically significant increase in central corneal thickness on day 7th and 30th post-operative day.[15]

In this prospective observational study, central corneal thickness increases immediately after uneventful phacoemulsification cataract surgery tends to normalize over 30 days. Hence, the changes that may occur in the CCT immediate period after phacoemulsification are mostly reversible and the resolving is near to the baseline levels. The possible explanation for this may be the grade of cataract, duration of surgery and type of machine used. This study provides valuable information regarding preoperative and postoperative rise in CCT which may further cause falsely elevated IOP reading which helps in determination of visual outcome after surgery which is affected due to corneal edema.

LIMITATION

This study had several limitations. The sample size was relatively small and recruited through convenience sampling, which may limit generalizability. As it was conducted at a single tertiary center, the findings may not reflect outcomes in other settings with different surgical techniques or patient profiles. Endothelial cell counts were not measured, preventing assessment of actual endothelial cell loss. The follow-up period was limited to 30 days, so longer-term changes in corneal thickness or endothelial recovery could not be evaluated.

CONCLUSION

This study confirms that phacoemulsification results in a temporary increase in central corneal thickness during the early postoperative period, reflecting transient endothelial dysfunction. The return of CCT to baseline by day 30 demonstrates adequate endothelial recovery following uncomplicated surgery. The low complication rate and resolution of edema highlight the overall safety of modern phacoemulsification techniques.

RECOMMENDATION

Routine monitoring of central corneal thickness is recommended during early postoperative follow-up to detect transient edema and interpret intraocular pressure accurately. Surgeons should continue using endothelial-protective techniques such as minimizing phaco energy and using appropriate viscoelastics. Future research with larger samples, longer follow-up, and inclusion of endothelial cell density measurements is advised to better understand endothelial recovery after phacoemulsification.

ACKNOWLEDGEMENT

All the authors expressed their heartfelt gratitude to all doctors and stuff working in Ophthalmology Department of CMCH.

DISCLOSURE

All the authors declared no competing interest.

https://doi.org/10.3329/cmoshmcj.v25i1.89967 Volume 25, Issue 1, January 2026

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