ORIGINAL ARTICLE

Change in Central Macular Thickness After Uncomplicated Phacoemulsification Cataract Surgery

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Abstract:

Objective: To determine the change in central macular thickness after uncomplicated phacoemulsification cataract surgery.

Methods: This cross-sectional study was conducted at the Helper's Eye hospital, Quetta from January 2022 to June 2022. A total of 126 patients aged between 40-70 years, having normal intraocular pressure and planned for phacoemulsification cataract surgery were included in this study. Central macular thickness was evaluated using **optical coherence tomography** 1 day before the operation and subsequently at weeks 1 and 4, post-operatively. The primary outcome of the study was the change in central macular thickness after uncomplicated phacoemulsification cataract surgery, while the secondary outcome was the frequency of patients with raised central macular thickness (an increase by 30% from the baseline), at week 4 following the phacoemulsification procedure.

Results: The mean age in this study was 56.16 ± 5.39 years. The female patients were 50.8% while male patients were 49.2% of total study population. There was a statistically significant increase in central macular thickness at week 4 after the procedure compared to the pre-operative levels (215.02±20.55 µm Vs 205.94±5.84 µm, $p<0.0001$). The result of secondary outcomes showed that incidence of raised central macular thickness was observed in 10 (7.9%) of the patients. Stratification of results established an association between diabetes and incidence of raised central macular thickness ($p=0.013$).

Conclusion: Phacoemulsification cataract surgery significantly increases central macular thickness postoperatively. Diabetes is significantly associated with both the overall increase and the development of raised central macular thickness. *Al-Shifa Journal of Ophthalmology 2025; 21(3): 160-167. © Al-Shifa Trust Eye Hospital, Rawalpindi, Pakistan.*

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Introduction:

Cataracts are widely recognized as a leading cause of vision loss, and surgical removal is the preferred treatment. Age-related cataracts are among the leading reasons of visual impairment at global level, followed closely by diabetes-related vision issues.[1]

From 1990 to 2019, the world wide burden of cataracts, measured in Disability-Adjusted Life Years (DALYs), was increased by 91.2%. The age-standardized prevalence and DALYs rates of cataracts peaked in 2017 and 2000 respectively. However, the burden is expected to decrease by 2050. The data for the year 2019 showed Southeast Asia as having the highest age-standardized DALY rates due to cataracts. Additionally, a gender

disparity is found since 1990, with females being more impacted than males. [2]

Cataract surgery is most commonly performed today using the phacoemulsification technique. This procedure helps restore vision in patients who have developed cataracts, regardless of the underlying cause.[3] In Pakistan, approximately 98.9% of cataract surgeries involve the use of intraocular lenses, and 63.9% of these surgeries are performed using the phacoemulsification technique.[4]

Cataract surgery is highly effective, but still carries the risk of both intraoperative and postoperative complications. One such complication is Pseudophakic Cystoid Macular Edema (CME), which can develop even after uncomplicated cataract procedures.[5]

Pseudophakic cystoid macular edema (CME), also known as Irvine-Gass syndrome, occurs due to inflammation-induced disruption of the blood-aqueous barrier, leading to increased macular thickness. Pseudophakic CME causes an increase in central macular thickness (CMT), leading to visual impairment and potentially hindering the achievement of optimal visual outcomes for the patient. [6,7,8]

The development of increased CMT in cases of Pseudophakic CME following cataract surgery is attributed to multiple pathological mechanisms. Surgical trauma triggers postoperative inflammation and causes the release of prostaglandins and vascular endothelial growth factor (VEGF). This trauma, along with traction on the macula during the procedure, leads to disruption of both the blood-retinal and blood-aqueous barriers. Consequently, there is leakage from perifoveal blood vessels, contributing to the formation of macular edema. These combined factors result in the characteristic increase in CMT observed in Pseudophakic CME.[9,10]

Pseudophakic PCME significantly impacts visual outcomes after successful cataract surgery. While most cases resolve within months, chronic PCME requires extended care. By excluding NSAIDs, common prophylactic agents, the study of natural progression of macular changes, can offer valuable guidance for post-cataract management. The most common and reliable method for studying macular changes after cataract surgery is Optical Coherence Tomography (OCT). Some authors argue that uncomplicated cataract surgery with intraocular lens implantation does not lead to the aforementioned factors, while they believe that complicated cataract surgeries, such as those involving a posterior capsular tear, may be more closely linked to these mechanisms. However, studies on changes in CMT measured by OCT after phacoemulsification cataract surgery have yielded mixed results, with some showing a decrease and others an increase in CMT.[11,12]

These differences may be attributed to factors such as race, healthcare infrastructure, phacoemulsification technology, and surgical technique.[13] Consequently, the studies conducted over the topic in our local health care institutes can find the significance of increased CMT and describe the type of patients who are at higher risk of developing this condition in post-cataract surgery. This research aimed to find the change in CMT after uncomplicated phacoemulsification cataract surgery, and frequency of patients with raised CMT following this procedure in our local population. The findings will provide ophthalmologists with a clearer understanding of this complication, enabling them to develop more effective post-operative management strategies.

Methodology:

This cross-sectional study was conducted at the Helper's Eye Hospital, Quetta from January 2022 to June 2022 over a period of 6 months. The sample size was calculated with following assumptions: Precision = 5.00%, Prevalence = 9.00 %.[14] Population size = infinite, with 95% Confidence Interval and Estimated sample size: n = 126. A total of 126 patients aged between

40-70 years, having normal intraocular pressure and planned for phacoemulsification cataract surgery were included in this study through consecutive sampling. Patients with pre-existing retinal pathology (e.g. glaucoma, diabetic retinopathy), uncontrolled diabetes, or pre-existing ocular edema were excluded. Patients who had previously undergone any intraocular surgery, suffered from any recent trauma to the eye or any intraoperative complications were also excluded.

Written informed consent was obtained from all patients prior to their inclusion in the study.

All the demographical details and medical history were recorded on a proforma designed for the purpose. Pre-operative measurement of CMT was done for all the patients by OCT. All subjects undergone phacoemulsification with local anesthesia avoiding any intracameral drug injection. The surgical procedure was consistent across all cases. A side port incision was created, followed by a 3.0-mm superior incision. Continuous curvilinear capsulorhexis was then performed. After hydrodissection with balanced salt solution, cataract removal was accomplished using the bimanual "divide-and-conquer" phacoemulsification method. Prior to implanting a foldable intraocular lens, sodium hyaluronate 1.4% was introduced into the capsular bag. Post-insertion, the viscoelastic material was completely removed. All procedures were completed without complications, with precise IOL positioning within the capsular bag. The postoperative regimen included a standardized steroid and antibiotic protocol for one month. To avoid potential effects on macular thickness, non-steroidal anti-inflammatory drugs were not administered (as NSAIDs are known to suppress postoperative inflammation and potentially mask the true incidence of macular thickening).

CMT evaluation via OCT was conducted one day before the operation and subsequently at weeks 1, 2, and 4. Fundus examinations, with full pupil dilation, were performed preoperatively and at each follow-up appointment. The primary outcome of the study was the change in CMT 4 week after uncomplicated phacoemulsification cataract surgery. The secondary outcomes was the frequency of patients with raised CMT at week 4 following the phacoemulsification procedure where the incidence of raised CMT was defined as an increase by 30% compared to the measurement taken before phacoemulsification surgery.[15]

Statistical analysis was conducted using SPSS 26. The mean and standard deviation was calculated for numerical variables such as age, pre- and post-operative intraocular pressure (IOP), pre- and post-operative CMT, phacoemulsification procedure time, and cataract duration. Categorical variables, including gender, diabetic and hypertension status, and number of patients with raised CMT after surgery, were presented using frequencies and percentages. Paired t-test was applied to find the significance of change in CMT keeping p-value of ≤ 0.05 as significant. The occurrence of raised CMT was stratified with age, comorbidities and length of procedure and the impact of these potential modifiers was assessed by applying Chi-square test. Statistical significance was confirmed when a p-value of ≤ 0.05.

Results:

The age range in this study was 40 to 70 years, with a mean age of 56.16 ± 5.39 years. The details of demographics, medical history and clinical findings are shown in Table-I.

Table-I: Demographics, medical history and clinical findings

n=126

Age (Mean±SD) years		56.16 ± 5.39
Duration of Cataract (Mean±SD) months		15.58±4.42
Gender	Male n (%)	62 (49.2)
	Female n (%)	64 (50.8)
Medical history	Diabetes n (%)	25 (19.8)
	Hypertension n (%)	19 (15.1)
Clinical findings	Preoperative IOP (Mean±SD) mm Hg	14.43±1.42
	Preoperative CMT (Mean±SD) µm	205.94±5.84
	Length of Procedure (Mean±SD) min	22.9±4.07

The comparison of preoperative and postoperative CMT showed significant increase in CMT after the phacoemulsification cataract surgery procedure. The incidence of raised CMT was observed in 7.9% of the patients as shown in Table-II.

Table-II: Findings related to CMT

n=126

Changes in CMT		
CMT	Preoperative (Mean±SD) µm	205.94±5.84
	Post-operative (Mean±SD) µm	215.02±20.55
	p-value*	<0.0001
Patients with raised CMT	Yes n (%)	10 (7.94)
	No n (%)	116 (92.06)

Paired t-test*

The incidence of raised CMT was also studied further by stratifying the incidence with respect to risk factors which established an association between the history of diabetes and incidence of raised CMT, however, no association was found with others possible risk factors as shown in Table-III.

Table-III: Stratification as per risk factors

n=126

Risk factors		Incidence of increased CMT		p-value*
		Yes n (%)	No n (%)	
Age	≤55 years (n=36)	2 (5.56)	34 (94.44)	0.53
	>55 years (90)	8 (8.9)	83 (92.2)	
Diabetes	Yes (n=25)	5 (20)	20 (80)	0.01
	No (n=101)	5 (5)	96 (95)	
Hypertension	Yes (n=19)	3 (15.8)	16 (84.2)	0.17
	No (n=107)	7 (6.54)	100 (93.5)	
Length of procedure	≤20 min (n=41)	4 (9.8)	37 (90.2)	0.6
	>20 min (n=85)	6 (7.06)	79 (92.94)	

Chi-squared test*

Discussion:

Changes in CMT after uncomplicated phacoemulsification cataract surgery has been discussed in different studies with different aims and with variety of outcomes.

Ozkurt Y and Akkaya S studied the incidences of CMT among diabetic patients with retinopathy, without retinopathy and patients without diabetes. The study reported that CMT increased until 3 months after cataract surgery and decreased gradually thereafter in patients with non-proliferative diabetic retinopathy (NPDR), until 1 month in diabetic patients without diabetic retinopathy(DR) and up to 1 week in patients without diabetes. The reported changes in these groups after 1 month of surgery were 12.76±6.83, 1.78±3.93 and 0.12±8.4 µm respectively with a statistically significant change in patients with NPDR (p=0.001). Similarly, the percentage of patients with increased CMT in these groups was 93%, 55.8% and 46.5% respectively.[16]

Jaafar AD assessed the changes in macular thickness with the use of spectral domain OCT after the uncomplicated procedure of phacoemulsification surgery in healthy subjects. During the two months following surgery, there was a notable rise in macular thickness. Significant changes were seen as early as the first week and persisted into the first and second months. Six eyes (7%) had pseudophakic CME at the end of the two-month research period.[17]

Kim BJ's also used OCT to assess macular thickness changes and edema following uncomplicated cataract surgery where change was defined as a 30% increase in CMT compared to preoperative measurements. Among the 376 participants, 36 (9.57%) were reported to develop macular edema postoperatively, as detected by OCT. CMT observed in this study at 1 month postoperatively was 198.5 ± 23.6 in patients having no edema, 237.8 ± 40.9 in patients having subclinical edema , and 314.0 ± 104.5, in patients with cystoid macular edema.[15]

A study conducted in Pakistan by Dad M evaluated macular thickness changes following uncomplicated phacoemulsification surgery using OCT. The study included patients aged 50-75 years with senile cataracts, excluding those with preexisting ocular or systemic conditions. Macular thickness was measured using swept-source OCT at: day 1, month 1, and months 6 post-surgery.

There was maximum raise in the CMT at the completion of 1 month after surgery (from 201.3±24.8μm preoperative reading to 224.1± 53.8 μm at 1 month time) which was then decreased back to 212.4±28.3μm at the end of 6 months. The study shared that this raised CMT don't affect the visual acuity which is also progressively improved in the post-operative period.[18]

Another study conducted in Pakistan by Shafi M investigated post-phacoemulsification changes in CMT, comparing diabetic and non-diabetic patients. OCT measurements were taken pre-operatively and 4 weeks post-surgery. Both groups showed statistically significant CMT increases: diabetics (223.10 ± 15.86 μm to 227.26 ± 17.90 μm, p<0.001) and non-diabetics (221.20 ± 12.16 μm to 226.28 ± 16.78 μm, p=0.001). However, the inter-group difference in CMT change was not statistically significant (p=0.486), suggesting similar macular responses to uncomplicated phacoemulsification in both diabetic and non-diabetic populations.[19]

Anand H compared macular thickness changes in diabetics without retinopathy and non-diabetics after uncomplicated phacoemulsification. CMT was measured pre-operatively and 6 weeks post-op. Both groups showed significant CMT increase (p<0.0001), but inter-group differences were insignificant pre-op (p=0.799) and post-op (p=0.938). Best Corrected Visual Acuity (BCVA) improvements were similar between groups (p=0.317 at 6 weeks), though intra-group changes were significant (p<0.0001). OCT revealed higher CMT increases in well-controlled diabetics in post-surgery phase. Short-term visual recovery was comparable between groups.[20]

Building upon these varied findings from international research works conducted earlier, our study is important by investigating the CMT changes in our local population. The mean age in this study was 56.16 ± 5.39 years. The female patients were 50.8% while male patients were 49.2% of total study population. There was a statistically significant increase in CMT at week 4 after the procedure compared to the pre-operative levels (215.02±20.55 μm Vs 205.94±5.84 μm, p<0.0001). Further analysis showed that this increase in CMT was consistent with different subgroups of patients irrespective of the age, co-morbidities and length of surgical procedure. The result of secondary outcomes showed that incidence of raised CMT was observed in 10 (7.9%) of the patients. The results of our study are in line with the studies discussed above and highlights the prevalence of raised CMT after 4 weeks following phacoemulsification surgery and thereby importance of its pre and post assessment using OCT. Stratification of results established an association between diabetes and incidence of raised CMT (p=0.013).This association between diabetes and increased CMT align with several previous studies discussed above.[14-,20]

The findings are constrained by a short follow-up period and a relatively small sample size, which can be taken as primary limitation of the research. Moreover, we only studied the changes in CMT and didn't worked on their clinical implications. Future studies with larger sample size, longer duration of follow-up and recording the clinical implicationswill enhance the valuable data available for cataract patients undergoing phacoemulsification surgery.

Conclusion:

Uncomplicated phacoemulsification cataract surgery significantly increases the CMT, where diabetic patients show particular vulnerability. These findings emphasize the need of thorough pre-operative and post-operative assessments, especially for high-risk patients. OCT evaluation during the first month post-surgery is therefore recommended for early detection of macular changes, so that the clinicians can consider prophylactic measures for patients and develop personalized follow-up protocols to

optimize visual outcomes. This will also help to prevent the complications related to increased macular thickness.

References:

1. Lin S, Ma Y, Hou Z, Congdon N, Lu L, Zou H. Andersen's utilization model for cataract surgical rate and empirical evidence from economically-developing areas. BMC Ophthalmol. 2021;21(1):1-8. doi: 10.1186/s12886-021-01858-x.
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(1):2068. doi: 10.1186/s12889-022-14491-0.
3. Gurnani B, Kaur K. Phacoemulsification. [Updated 2023 Jun 11]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK576419/.
4. Khan AA, Awan HR, Khan AQ, Hussain A, Awan ZH, Jadoon MZ. Determining the National Cataract Surgical Rate in Pakistan. Middle East Afr J Ophthalmol. 2022;28(4):245-51. doi: 10.4103/meajo.meajo_266_21.
5. Oli A, Waikar S. Modified inexpensive needle for suprachoroidal triamcinolone acetonide injections in pseudophakic cystoid macular edema. Indian J Ophthalmol. 2021;69(3):765-7. doi: 10.4103/ijo.IJO_1464_20.
6. Marques JH, Abreu AC, Silva N, Meireles A, Pessoa B, MeloBeirão J. FluocinoloneAcetonide 0.19 mg Implant in Patients with Cystoid Macular Edema Due To Irvine-Gass Syndrome. Int Med Case Rep J. 2021;14:127-32. doi: 10.2147/IMCRJ.S295045
7. Delfi, Sihotang A, Hamonangan Ms. Incidence of Macular Cystoid Edema After Cataract Surgery with Optical Coherence Tomography Examination At H. Adam Malik Medan Hospital and Dr. Pirngadi Medan Hospital. Int J Res Pub.2021;71(1):58-68. doi: 10.47119/IJRP100711220211762.
8. Grzybowski A, Sikorski BL, Ascaso FJ, Huerva V. Pseudophakic cystoid macular edema: update 2016. ClinInterv Aging. 2016;11:1221-1229. doi: 10.2147/CIA.S111761.
9. Rathore P, Chander A, Rastogi PS. Effect of cataract surgery on macular thickness in diabetic patients. Int J Med Ophthalmol. 2020;2(2):73-76 doi: 10.33545/26638266.2020.v2.i2b.43.
10. Heesterman BL, Hogewind BF. Phacoemulsification and intraoperative complications in 452 patients with diabetic retinopathy. SeminOphthalmol. 2017;32(4):395-6.
11. Zhou Y, Zhou M, Wang Y, Ben S, Gao M, Zhang S, Liu H, Sun X, et al. Short-Term Changes in Retinal Vasculature and Layer Thickness after Phacoemulsification Surgery. Curr Eye Res. 2020;45(1):31-7. doi: 10.1080/02713683.2019.1649703.
12. Abdellatif MK, Ebeid WM. Variations in Choroidal and Macular Thickness Maps after Uneventful Phacoemulsification. SeminOphthalmol. 2018;33(5):719-725. doi: 10.1080/08820538.2017.1417453.
13. Helayel HB, Alyahya AA, Al Owaifeer AM, Khan AM, Al Zahrani AT, Badawi AH, et al. Risk factors, complications, and outcomes of phacoemulsification cataract surgery complicated by retained lens fragments in Asian eyes: A 10-year retrospective study. Saudi J Ophthalmol. 2022;36(2):171-176. doi: 10.4103/sjopt.sjopt_122_22.
14. Wangab K, Cheng C. Central retinal thickness changes and visual outcomes following uncomplicated small-incision phacoemulsification cataract surgery in diabetic without retinopathy patients and nondiabetic patients. Taiwan J Ophthalmol. 2014;4(1):33-9.

15. Kim BJ, Ahn YJ, Oh HY, Choi SI, Yoo YS, Whang WJ, et al. Assessment for Macular Thickness after Uncomplicated Phacoemulsification Using Optical Coherence Tomography. Korean J Ophthalmol. 2022 Aug;36(4):296-305. doi: 10.3341/kjo.2021.0171.
16. Akkaya S, Ozkurt Y. Changes in central macular thickness after uncomplicated phacoemulsification surgery in diabetic and non-diabetic patients. Beyoglu Eye J. 2018;3(1):13-9.
17. Jaafar AD, Abdulkareem SA, Jaafar MDJ. Macular oedema after uncomplicated phacoemulsification. Afr Vision Eye Health. 2022;81(1):a690. https://doi.org/10.4102/aveh.v81i1.690
18. Dad M, Tahir MA, Cheema A, Nawaz HN. Change in macular thickness after uncomplicated phacoemulsification surgery using optical coherence tomography in a tertiary care hospital. Pak J Med Sci. 2023 Sep-Oct;39(5):1488-1491. doi: 10.12669/pjms.39.5.4775.
19. Shafi M, Khan MA, Lodhi Y, Aftab A, Sarfraz MH. Central Macular Thickness After Cataract Surgery in Patients with Diabetes Mellitus And without Diabetes Mellitus. Pak Armed Forces Med J. 2021;71(6): 1993-6. Doi: https://doi.org/10.51253/pafmj.v6i6.6840.
20. Anand H, Kumari R, Bhagat DK.To study the centralmacular thickness changes following uncomplicated phacoemulsification in diabetic patients without retinopathy. Int J Acad Med Pharm.2023;5(4); 856-62. DOI: 10.47009/jamp.2023.5.4.173.

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