Original Article

Changes in Central Corneal Thickness and Central Macular Thickness following Uncomplicated Small-incision Cataract Surgery

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ABSTRACT

Introduction: Cataract surgery is an invasive procedure that causes mechanical and inflammatory insult to the eye.

Objectives: The objective was to study the changes in central corneal thickness (CCT) which is an indirect indicator of corneal endothelial dysfunction and the changes in macular thickness following uncomplicated small incision cataract surgery (SICS)

Materials and methods: This was a prospective observational study with a before-and-after design conducted in Reiyukai Eiko Masunaga eye hospital, Banepa, Kavrepalanchok, Nepal. SICS was performed on 68 eyes of 62 patients. Change in CCT and central macular thickness (CMT) from baseline was observed post-surgery on the first day, one week, and six weeks.

Results: There were 27 (43.5%) females and 35 males (56.5%) in the study. Mean age was 58.26 ±10 years. This difference of visual acuity between pre and post-operative state was statistically significant. The first post-operative day (POD) and first week post-operative CCT values when compared with preoperative CCT values were statistically significant. However, post-operative CCT values at six weeks were similar to preoperative values. Also, the differences at day one, first week and six weeks post-operative CMT values when compared with preoperative CMT values were statistically significant.

Conclusion: This study revealed that there is a significant rise in CCT after SICS which gradually tends to normalize at six weeks. Similarly there is a gradual rise in CMT after SICS persisting even at six weeks. These changes were subtle and there was a marked improvement of visual acuity at six weeks after SICS.

Key word: Cataract surgery, Central corneal thickness, Central macular thickness.

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INTRODUCTION

Age-related cataract is the most significant cause of bilateral blindness throughout the world. According to World Health Organization (WHO) 47.8% of global blindness is due to cataract (Avachat et al, 2014). Nepal is one of the first countries in the world where a country-wide survey on blindness was conducted (1980-81). The prevalence of blindness in 1981 A.D. was found to be 0.84% (Brilliant et al, 1985). The prevalence of blindness reduced from 0.84% in 1981 to an estimated 0.35% in 2011, a reduction of 58% (Sapkota et al, 2013). The reduction in the burden of cataract has obviously been achieved by innumerable cataract surgeries.

Cataract surgery is evolving year after year and we now understand the physiological changes that take place after surgery than ever before. Cataract extraction affect corneal endothelial density. Moderate damage to the endothelium during surgeries can lead to endothelial cell loss and subsequent transient increase in corneal thickness which can be monitored by measurement of central corneal thickness (CCT) (Portellinha et al, 1991). Researchers have therefore put their effort in the assessment of endothelial damage either by cell counts or by measuring corneal thickness post-operatively. Endothelial cells loss results in an increase in corneal thickness. If severe enough it can culminate into corneal decompensation and loss of vision (Sobottka et al, 2001).

Cataract surgery is an invasive procedure that causes inflammatory insult to the eye (Falcao et al, 2013). Cataract surgery induced surgical trauma resulting in prostaglandins release and blood retinal barriers disruption is thought to be the cause of macular edema (Kim et al, 2010). Techniques such as optical coherence tomography (OCT) can help to detect any microscopic changes in the macula. OCT can assess macular thickness quantitatively; it can detect subtle changes of macular thickness and is especially useful to assess the change in macular thickness after cataract surgery at regular intervals (Singhi et al, 2017).

Taking into consideration the physiological changes that occur after cataract surgery as mentioned above, this study was intended to assess the CCT (that depicts endothelial cell loss and compensation) and the central macular thickness (CMT) (macular response to inflammation) after uncomplicated manual small incision cataract surgery (SICS). The objectives of the study were to study the changes in central corneal thickness (CCT) which is an indirect indicator of corneal endothelial dysfunction and changes in macular thickness following uncomplicated SICS.

MATERIALS AND METHODS

This was a prospective observational study with a before-and-after design conducted in Reiyukai Eiko Masunaga eye hospital in Banepa, Kavrepalanchok, Nepal after approval from local ethical committee (Reference number: LEB-REMEH: 03/20). The study duration spanned three months, from August 1, 2020, to October 30, 2020.

Consecutive patients undergoing SICS in the study duration and meeting the inclusion criteria were included in the study (Figure 1). Written informed consent was taken from all the patients. . Notably, the study employed a consecutive sampling approach, where patients meeting the criteria were included. Patients or the public were not involved in the design, or conduct, or reporting, or dissemination plans of our research.

Patients were eligible for enrollment if they met the following criteria: 1) Cataract allowing pre-operative CCT (corneal pachymetry) and CMT (central macular thickness) assessment, 2) patients with stable fixation, 3) absence of corneal, retinal, or macular pathologies, 4) uneventful standard SICS (small incision cataract surgery), and 5) absence of glaucomatous changes. Exclusion criteria encompassed 1) mature cataract, 2) traumatic cataract, 3) complicated cataract, 4) intraoperative complications, 5) corneal, retinal, or macular pathologies, 6) concurrent glaucoma and uveitis, 7) astigmatism exceeding 2 diopters, and 8) diabetes mellitus.

A comprehensive ocular examination was conducted for all enrolled patients, encompassing pre-operative, per-operative, and postoperative assessments. Preoperative examination consisted of determination of best corrected visual acuity by Snellen's chart (converted to logMAR for statistical analysis), Slit lamp examination of the anterior segment; Fundus examination using + 90D lens; CCT (Accutome 4 sight); CMT using 3D macular scans (Topcon 3D OCT) Per-operative examination consisted of noting the following points: Site of incision, length of incision; total duration of the surgery. Follow-up examination (one week and six weeks) included assessment of best corrected visual acuity; Slit lamp examination of the anterior segment; fundus examination using +90D lens; and measurements of CCT and CMT. Best corrected visual acuity at six weeks was considered as final visual acuity for analysis. Surgical technique was same for all patients. A six millimeter Polymethyl methacrylate (PMMA) single piece rigid intraocular lens was implanted in the bag at the end of surgery. Any complication during surgery excluded the patients from the study (Figure 1). Post-operative medications included antibiotics and steroids.

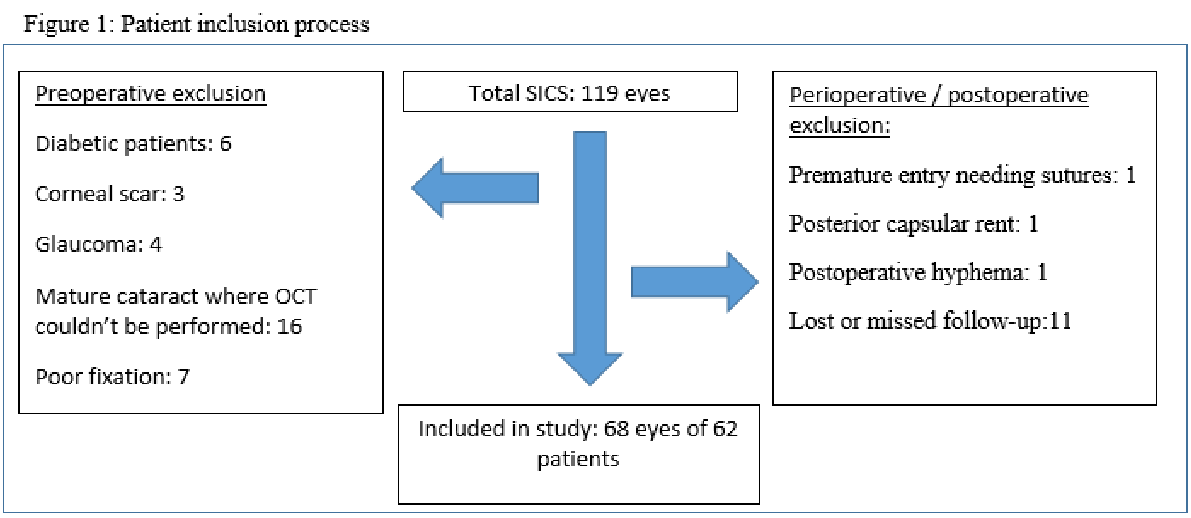

Figure 1: Patients' inclusion and exclusion criteria

We entered paper-based collected data into Microsoft Excel and imported it into STATA version 17 for cleaning, coding, and statistical analysis. We evaluated the data's normality through visual means, encompassing the examination of histograms and the application of the Shapiro-Wilk test. To assess the impact of small-incision cataract surgery on central corneal thickness and central macular thickness, we opted for the Paired t test to compare the mean visual acuity before and after the procedure. Additionally, we employed a repeated measures analysis of variance (ANOVA) approach to gauge the mean values at various follow-up intervals, followed by Tukey's post hoc analysis to pinpoint specific differences between these time points. A significance level of alpha < 0.05 was established for all our statistical tests. Our findings were presented using descriptive statistics, which included means and standard deviations, and relevant p-values and confidence intervals were provided where applicable.

RESULTS

Of 119 eyes which underwent SICS in the study duration, 68 eyes of 62 patients were included in the study (Figure 1). Mean age was 58.26 ±10 years (Range: 38-80 years; 95% CI: 55.82-60.80) (Table 1).

Mean duration of surgery was 7.96±2.74 minutes. Mean best corrected preoperative visual acuity was 0.59±0.40 logMAR unit whereas mean best corrected post-operative visual acuity at six weeks was 0.19±0.21 logMAR unit. This difference of visual acuity between pre and post-operative state was statistically significant (p <0.05) with Paired t test (Table 2).

Means of preoperative CMT, first post-operative day CMT, one week post-operative CMT and six weeks post-operative CMT values were compared using repeated measures of anova test which showed a statistically significant difference. Post hoc analysis of individual

Table 1: Demographic profile of patients

Variable		Frequency	Percent
Gender	Males:	35	56.5
	Females	27	43.5
Eye undergoing surgery	Right eye	26	38.2
	Left eye	42	61.8

Table 2: Preoperative and post-operative best corrected visual acuity.

Variable	Mean	Std. dev.	95% Confidence interval		p value*
Preoperative VA in LogMAR	0.59	0.40	0.49	0.68	<0.01
Post-operative VA in LogMAR	0.19	0.21	0.14	0.24	

Abbreviations: VA, visual acuity, logMAR: Logarithm of minimum angle of resolution

Note**:** *Paired t test

groups showed a statistically significant difference between preoperative and first post-operative day CMT values. Similarly a statistically significant difference between "first post-operative day CMT and one week post-operative CMT" and "one week post-operative CMT and six weeks post-operative CMT" was found. There was also a significant difference of mean preoperative and six weeks post-operative CMT indicating that the difference of CMT tends to persist even at six weeks of surgery.

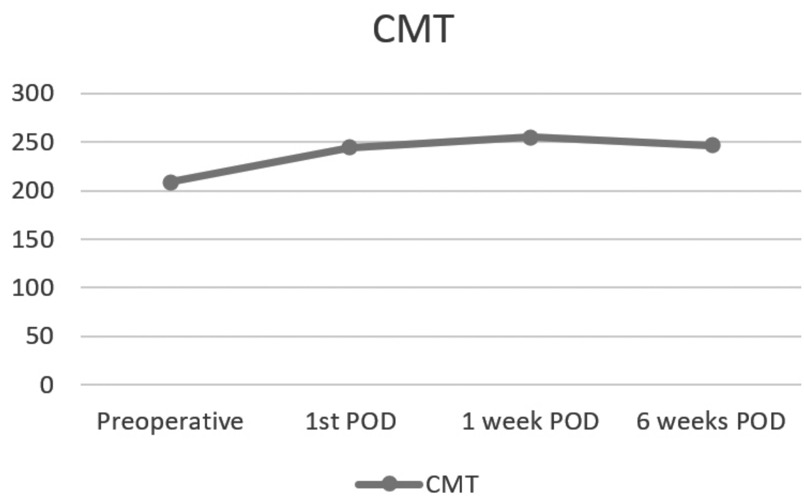

Figure 2: Progression of mean central macular thickness at different days of surgery

Table 3: Analysis of central macular thickness (CMT) values at various time intervals of surgery

	Preoperative CMT (µm)	CMT on first post-operative day (µm)	CMT at 1 week of surgery (µm)	CMT at 6 weeks of surgery (µm)	p value*
Mean	208.94	243.89	255.07	246.48	<0.001
Std. dev.	38.78	36.2	35.16	36.24	
95% Confidence interval	199.55	235.13	246.56	237.71	
	218.32	252.65	263.58	255.25	

*p value obtained with repeated test ANOVA, considered significant if <0.05.

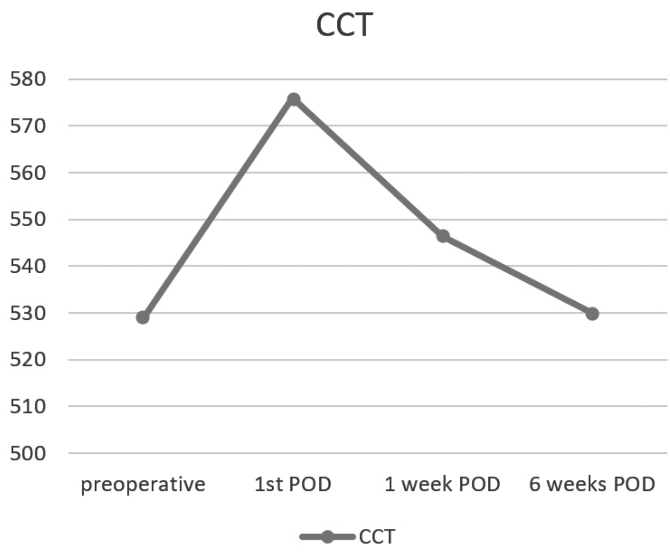

Figure 3: Progression of mean central corneal thickness at different days post-surgery

Table 4: Analysis of central corneal thickness (CCT) values at various time intervals of surgery

	Preoperative CCT (µm)	CCT on first post-operative day (µm)	CCT at 1 week of surgery (µm)	CCT at 6 weeks of surgery (µm)	p value*
Mean	528.79	575.91	546.3	529.97	<0.001
Std. dev.	8.49	15.65	12.7	7.64	
95% Confidence interval	526.73	572.12	543.23	528.12	
	530.85	579.7	549.38	531.82	

*P value obtained with repeated test ANOVA, considered significant if <0.05%.

Means of Preoperative CCT, first post-operative day CCT, one-week post-operative CCT and six weeks post-operative CCT values were statistically significant when compared using repeated measures of ANOVA test. Post hoc analysis with Tukey's test of individual groups showed a statistically significant difference between preoperative and first post-operative day CCT values. Similarly, a statistically significant difference between "first post-operative day CCT and one-week post-operative CCT" and "1 week post-operative CCT and 6 weeks post-operative CCT" was also found. However, there was no significant difference of mean preoperative and six weeks post-operative CCT indicating that CCT tends to normalize at six weeks of surgery.

DISCUSSION

Mean age of patients in our study population was 58.26 ±10 years. The presence of elderly population in our study group reestablishes the aging process as the commonest etiology of uncomplicated cataract. Males constituted a larger proportion in the study. This was similar to study conducted by Mganaga et al (2011) where cataract was seen mostly in the elderly population and in males.

Endothelial cell loss, which clinically presents as corneal edema, acts as a measure for estimating the safety of the surgical technique. Our study showed that in manual small incision cataract surgery, the mean CCT on day first post-operative increased from 528.79 µm baseline CCT to 575.91 µm. Mean CCT was 546.31±12.7 µm one week post-operatively and slight decrease to 529.97 was noted at six week post-operatively. Hence, it shows that there was some endothelial cell loss leading to a change in corneal thickness in first few weeks of surgery but was well compensated at six weeks post-operative. This is similar to study conducted by Jacob (1985) that reported that maximal increase occurred within 24 hours following cataract surgery. This study was similar to other studies conducted where initial increase followed by gradual decrease in corneal thickness was recorded following cataract surgery (Bolz et al, 2006; Ventura et al, 2001; Cheng et al, 1988).

Subclinical changes may occur in macular thickness without the visual acuity being affected. In this study there was a statistically significant increase in post-operative CMT values from baseline. Gharbiya et al (2013) demonstrated a progressive increase in retinal thickness after uncomplicated cataract surgery. Only at six months after surgery, retinal thickness tended to normalize in the central fovea (Gharbiya et al., 2013). Yoo et-al (2012) studied the changes in central subfield macular thickness (CSMT) using OCT after cataract surgery. They concluded at one month CSMT significantly increased by 22.2 ± 47.10 µm after cataract surgery in the operated eye compared with the fellow eye (p= 0.01). There was a significant improvement in best corrected visual acuity (BCVA). The improvement in vision was statistically significant (p value 0.041). It, thus, concludes that there is endothelial cell loss leading to increased CCT values and an increase in CMT but not to the extent to cause visual impairment following uncomplicated SICS in healthy individuals.

Our study has certain limitations, including a small sample size and a relatively short follow-up duration. We employed CCT as an indirect indicator to assess endothelial cell function, utilizing Ultrasound pachymetry for measurement, which is known to exhibit greater variability. Employing specular microscopy for endothelial assessment might have potentially yielded more robust and reliable results.

CONCLUSION

This study revealed that there was a significant rise in CCT after SICS which gradually tended to normalize at six weeks. Similarly there was a gradual rise in CMT after SICS persisting even at six weeks. However these changes were subtle and there was a marked improvement of visual acuity after SICS.

Abbreviations: Central Corneal Thickness (CCT) , Central macular thickness (CMT), Small-Incision Cataract Surgery (SICS), Post-operative day (POD), Central subfield macular thickness (CSMT), Ocular coherence tomography (OCT).

REFERENCES

Avachat SS, Phalke V, Kambale S (2014). Epidemiological correlates of cataract cases in tertiary health care center in rural area of Maharashtra. J Family Med Prim Care. Jan; 3(1):45-7. doi:10.4103/2249-4863.130273

Bolz M, Sacu S, Drexler W, Findl O (2006). Local corneal thickness changes after small-incision cataract surgery. J Cataract Refract Surg; 32(10):1667–1671. doi:10.1016/j.jcrs.2006.05.018

Brilliant LB , Pokhrel RP, Grassat NC, Lepkowski JM, Kolstad A, Hawks W et al (1985). Epidemiology of blindness in Nepal. Bulletin of World health organisation;63(2):375-386. PMID: 3874717; PMCID: PMC2536402.

Cheng H, Bates AK, Wood L (1988). Positive correlation of corneal thickness and endothelial cell loss. Arch Ophthalmol;106:920–922. doi:10.1001/archopht.1988.01060140066026

Falcão M, Goncalves N, Freitas-Costa P, Beato J, Rocha-Sousa A, Carneiro A et al (2013). Choroidal and macular thickness changes induced by cataract surgery. Clinical Ophthalmology;55.doi: https://doi.org/10.2147/OPTH.S53989

Gharbiya M, Cruciani F, Cuozzo G, Parisi F, Russo P, Abdolrahimzadeh S (2013). Macular thickness changes evaluated with spectral domain optical coherence tomography after uncomplicated phacoemulsification. Eye (Lond);27(5): 605–611.doi:10.1038/eye.2013.28

Jacob JS (1985). Corneal thickness changes following cataract surgery: effect of lens implantation and sodium hyaluronate. Br J Ophthalmol;169(8):567–571. doi:10.1136/bjo.69.8.567

Kim S, Flach A, Jampol L (2010).Nonsteroidal anti-inflammatory drugs in ophthalmology. Surv Ophthalmol; 55(2):108– 133. Doi:10.1016/j.survophthal.2009.07.005

Mganaga H, Lewallen S, Courtright P (2011). Overcoming gender inequity in prevention of blindness and visual impairment in Africa. Middle East African. J Ophthalmol; 18(2):98–101doi: 10.4103/0974-9233.80695

Portellinha W, Belfort R Jr (1991). Central and peripheral corneal thickness in newborns. Acta Ophthalmol; 69: 247–250.doi: 10.1111/j.1755-3768.1991.tb02719

S Sapkota, YD & Limburg H (2013). Epidemiology of Blindness in Nepal: 2012.

Singhi A, Baishya K (2017). A study on changes in macular thickness after cataract surgery in diabetic patients using optical coherence tomography (OCT). Int J Sci Res; 6(9):1432-1437.

Ventura ACS, Wälti R, Böhnke M. (2001) Corneal thickness and endothelial density before and after cataract surgery. Br J Ophthalmol; 85:18–20.doi:10.1136/bjo.85.1.18

Yoo JH, Kim SY, Lee SU, Lee SJ (2012). Changes in Macular Thickness after cataract surgery According to optical Coherence Tomography. J Korean Ophthalmol Soc; 53(2):246-255. doi:https://doi.org/10.3341/jkos.2012.53.2.246