Original Article

Study of Central Corneal Thickness (CCT) Before and After Small-Incision Cataract Surgery (SICS) and Phacoemulsification Surgery

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Abstract

Purpose: To highlight the importance of measurement of central corneal thickness (CCT) which is an indirect indicator of corneal endothelial dysfunction after cataract surgery. **Materials and Methods:** This was a randomised control trial involving 101 patients who presented with cataract. Cataracts were graded using Lens Opacities Classification system grading. Fifty-one patients underwent small incision cataract surgery (SICS) and 50 underwent phacoemulsification (PHACO). Patients with any other ocular pathology were excluded. **Results:** There was significant improvement in the best corrected visual acuity (BCVA) comparable in both groups. There was a statistically significant increase in central corneal thickness on day 7th and 30th post op. The change in the CCT and BCVA was comparable between SICS and PHACO on day 30th post op. **Conclusion:** The increase in CCT suggests that there was some endothelial cell loss leading to change in corneal thickness but not to the extent of causing visual impairment. SICS and phacoemulsification surgery are comparable in respect to visual rehabilitation. Manual SICS is still a safe and cost-effective option in the developing world. Proper case selection, diligent surgery, and adequate postoperative care are essential to maintain a clear cornea.

Keywords: Cataract, CCT, phacoemulsification, SICS

Introduction

Senile cataract has been documented to be the most significant cause of bilateral blindness in India. The most recent estimates from World Health Organization reveal that 47.8% of global blindness is due to cataract.[1] In India, cataract is the principal cause of blindness accounting for 62.6%.[2] The key to the success of the Global Vision 2020: The right-to-sight initiative is a special effort to tackle cataract blindness which includes the estimation of magnitude of the problem and understanding the factors associated with it. The burden of global cataract blindness continues to rise, because the number of surgical ophthalmologists is insufficient, and they are unevenly distributed. Hence there is an urgent need to train surgeons quickly and comprehensively in high-quality, low-cost cataract removal techniques.[3]

Management of this age-old impairment of vision requires surgical treatment in the form of manual removal of the lens which is either by intracapsular lens extraction or extracapsular lens extraction [small-incision cataract surgery (SICS)] or by phacoemulsification (PHACO) with intraocular lens (IOL) implantation.

The aim of cataract surgery is no longer restricted to just visual restoration, but is now considered to be a refractive surgery, that is, to achieve a state of emmetropia. Because of these changing trends regarding results of cataract surgery, the surgical technique has revolutionized rapidly.

Recent advances in cataract surgery have reduced the incidence of corneal complications; however, this new technology has also led to various new complications such as mechanical or toxic injury to endothelium.[4] Moderate damage to the endothelium during surgery can lead to a

Access this article online

Quick Response Code:

Website: www.nigerianjournalofophthalmology.com

DOI: 10.4103/njo.njo_30_16

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How to cite this article: Deshpande S, Agarwal A, Shah P, Gala Y. Study of central corneal thickness (CCT) before and after small-incision cataract surgery (SICS) and phacoemulsification surgery. Niger J Ophthalmol 2018;26:35-9.

transient increase in corneal thickness. Detrugescene of the corneal stroma is controlled by the pumping action of the endothelial layer and can be monitored by measurement of central corneal thickness (CCT). Loss or damage of endothelial cells leads to an increase in corneal thickness, which may ultimately induce corneal decompensation and loss of vision.[5] Careful attention during cataract surgery and in the postoperative period can prevent most corneal complications.

In India, from around 1.2 million cataract surgeries per year in the 1980s, the cataract surgical output increased to 3.9 million per year by 2003.[1] Therefore, it is important to determine a safe, quick, and cost-effective surgical technique which will lead to lesser postoperative complications.

Both PHACO and SICS achieve excellent visual outcomes with low-complication rates, and SICS is significantly faster, less expensive, and less technology dependent than PHACO. Therefore, it may be a preferred surgical procedure for the treatment of cataracts in the developing world.[6]

Preservation of corneal endothelial function is a major goal in cataract surgery as literature proves that the measurement of corneal edema is an indirect indicator of corneal endothelial function, which plays an important role in maintaining the corneal transparency and, thus, visual rehabilitation.[5]

This study aims to highlight the importance of measurement of CCT which is an indirect indicator of corneal endothelial dysfunction postcataract surgery, as there are very limited data available from India on the effect of SICS and PHACO on the corneal endothelium.

Materials and Methods

This was a prospective study consisting of 101 patients who presented to the Department of Ophthalmology, who fulfill inclusion criteria, and are willing to enroll in the study.

Standard, uneventful SICS was performed on 51 patients, and standard, uneventful, clear, corneal PHACO was performed on 50 patients. Change in CCT was observed postsurgery on day 7th and day 30th. This study was conducted over a period of 2 years.

After taking informed consent, detailed history regarding patients' name, age, sex, occupation, address, presenting symptoms, duration, progression, and associated conditions was recorded.

The procedure done was SICS with posterior IOL implantation or Phaco with posterior IOL implantation under local anesthesia. The CCT was measured using ultrasound pachymetry under topical anesthesia.

All the patients were examined and selected for cataract surgery as per standard protocol.

Inclusion criteria

(1) Age: 50–70 years.
(2) Patients with grade 2 cataract [according to lens opacities classification system (LOCS) classification II].
(3) Patients who underwent uneventful standard SICS or PHACO surgery.
(4) Patient with no glaucomatous changes.
(5) Patients with no corneal pathology.
(6) Patients who were willing to undergo a follow-up to a period of 3 months.

Exclusion criteria

(1) Any deviation in the operative steps other standard.
(2) Any intraoperative complicated cases.
(3) Prolonged surgery time (normal: 15–20 min).
(4) Postoperative trauma.
(5) Postoperative infection.
(6) Failure to follow-up.

Preoperative assessment

All the patients were admitted 1 day before the surgery. After obtaining informed consent, a detailed history regarding patient's name, age, sex, occupation, address, presenting symptoms, duration, progression, and associated conditions was recorded. General systemic examination was conducted to rule out any systemic illness and relevant investigations conducted to rule out the same.

This was followed by a detailed ocular examination, in which materials used were as follows:

(1) Snellens visual acuity chart for testing vision and preoperative refraction was performed.
(2) Appaswamy slit lamp for detailed anterior segment examination and grading of cataract.
(3) Posterior segment was evaluated using both direct and indirect ophthalomoscopy.
(4) Schiozt tonometer for measuring intraocular pressure.
(5) Alcon A Scan pachymeter for measuring the CCT.
(6) Bausch and Lamb Keratometer for keratometry and Alcon IOL calculator for IOL power using SRK II formula.
(7) Optikon PHACO machine.
(8) Microscope (Takagi or Zeiss) for surgery.

Observations and Results

Baseline characteristics

Total number of patients operated for SICS was 51 and for PHACO was 50. Total number of males in SICS was 24 and in PHACO was 28. Total number of females in SICS was 27 and in PHACO was 22. The mean age for SICS was 62.66667 and for PHACO was 62.18.

The baseline mean CCT in SICS was 509.098 and in PHACO was 518.46. The baseline IOP in SICS was 18.5451 mmHg and in PHACO was 18.834 mmHg. There was no significant difference between the baseline line parameters between the two groups.

Best-corrected visual acuity between the two groups

The baseline mean best-corrected visual acuity (BCVA) in both the groups was comparable. In SICS mean BCVA was 0.4694118 and in PHACO mean BCVA was 0.4476. There was a statistically significant improvement in the BCVA in both the groups. The mean BCVA at day 30 in SICS was 0.882353 and in PHACO was 0.1116 [Figure 1; Table 1].

The increase in the BCVA was statically insignificant (*P* value 0.1931) between the two groups. Thus, the change in BCVA was comparable.

Central corneal thickness parameters in small-incision cataract surgery

The preoperative value of mean CCT was 509.098, on day 7th was 528.9608 and on day 30th was 514.1569 [Figure 2; Table 2].

The mean value of CCT on postoperative day 7th is 528.9608. Paired *t* test showed *P* value 0.0000. There was a statistically significant increase ($P < 0.05$) in CCT on day 7th.

The mean value of CCT on postoperative day 30th is 514.1569. Paired *t* test showed *P* value 0.0000. There was a statistically significant increase ($P < 0.05$) in CCT on day 30th when compared to preoperative values [Table 3].

Table 1: Shows comparison of BCVA between two groups

	Mean BCVA	
	Preoperative	Day 30th
SICS	0.4694118	0.882353
PHACO	0.4476	0.1116

Table 2: Mean CCT

	Mean CCT
Preoperative	509.098
Day 7th	528.9608
Day 30th	514.1569

Table 3: Central corneal thickness parameter and paired *t* test

	Preoperative	Day 7th	Day 30th
Mean CCT	509.098	528.9608	514.1569
Standard deviation	23.18297	22.12146	23.09145
P values	–	0.0000	0.0000

Table 4: Mean CCT

	Mean of CCT
Preoperative	518.46
Day 7th	533.78
Day 30th	524.9

Hence, it shows that there was some endothelial cell loss leading to change in corneal thickness but not to the extent to cause visual impairment postoperatively.

Central corneal thickness parameters in phacoemulsification surgery

The preoperative value of mean CCT was 518.46, on day 7th was 533.78 and on day 30th was 524.9 [Figure 3; Table 4].

The mean value of CCT on postoperative day 7th is 533.78. Paired *t* test showed *P* value 0.0000. There was a statistically significant increase ($P < 0.05$) in CCT on day 7th.

The mean value of CCT on postoperative day 30th is 524.9. Paired *t* test showed *P* value 0.0001. There was a statistically significant increase ($P < 0.05$) in CCT on day 30th when compared to preoperative values [Table 5].

Hence, it shows that there was some endothelial cell loss leading to change in corneal thickness but not to the extent to cause visual impairment postoperatively.

Table 5: Central corneal thickness parameter and paired *t* test

	Preoperative	Day 7th	Day 30th
Mean CCT	518.46	533.78	524.9
Standard deviation	19.53355	22.99271	19.52523
P values	–	0.0000	0.0001

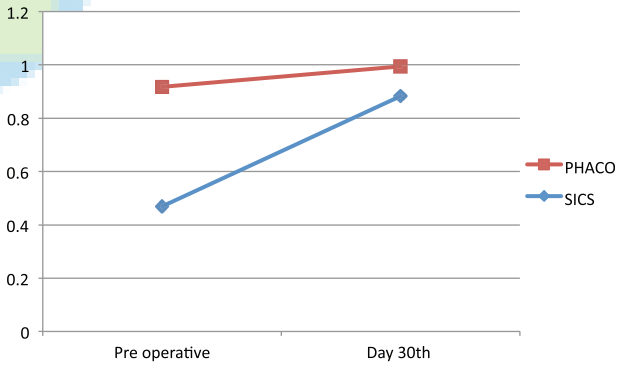

Figure 1: The comparison of BCVA between two groups

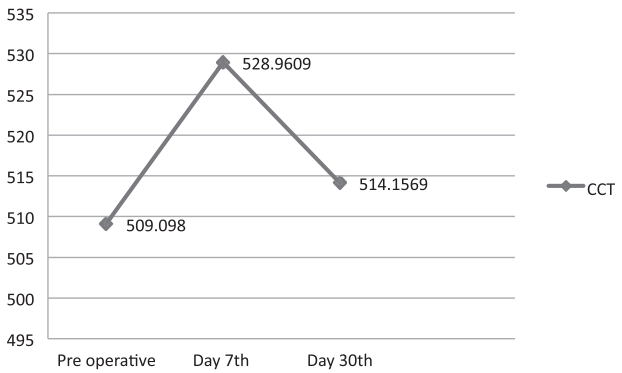

Figure 2: Progression of mean central corneal thickness at different days of surgery

Comparison between small-incision cataract surgery and phacoemulsification surgery

The preoperative CCT values showed no significant difference between the two groups. Both groups showed an increase in CCT values on postoperative day 7 indicating some endothelial cell disturbances, but the increase in CCT was comparable between the two groups (*P* value 0.1353). At day 30, there was a decrease in CCT value as compared to day 7 The decrease was more in SICS as compared to PHACO, but the difference between the two groups was statistically insignificant (*P* value 0.4024) when compared to preoperative values. This indicates that the endothelial cell loss in both the groups were comparable. The improvement in BCVA was comparable (*P* value 0.1931) between the two groups at the end of day 30 [Figure 4; Table 6].

Table 6: Comparison of CCT in SICS and PHACO

	SICS	PHACO
Preoperative CCT	509.098	518.46
CCT on day 7th	528.9608	533.78
CCT on day 30th	514.1569	524.9

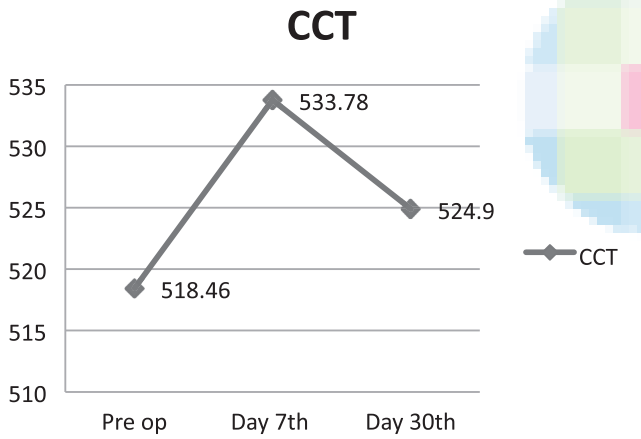

Figure 3: Progression of mean central corneal thickness at different days of surgery

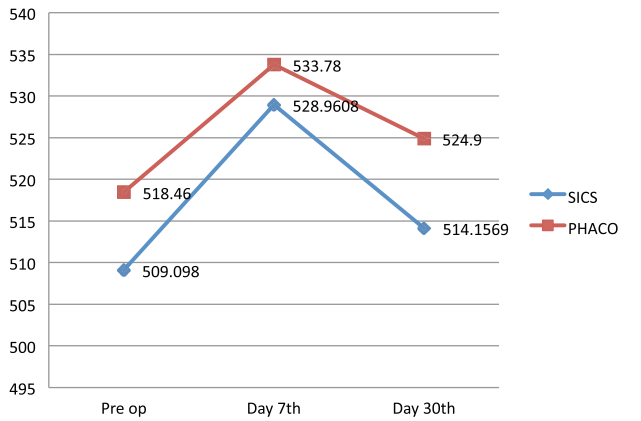

Figure 4: Comparison of CCT in SICS and PHACO

Discussion

Cataracts constitute a significant volume of visual impairment in developing countries such as India. In the developing countries, where cataract backlog is still a socioeconomic problem, but procedures such as PHACO remain an expensive modality of management and majority of the population find it difficult to afford. Manual small-incision cataract surgery (MSICS) promises safety of this procedure.

Corneal edema is an indirect indicator of corneal endothelial function which plays an important role in maintaining the corneal transparency and, thus, is vital for visual rehabilitation. Endothelial alteration is considered an important parameter of surgical trauma and essential for estimating the safety of the surgical technique. Hence, the preservation of corneal endothelial function continues to be a major goal as cataract surgery continues to evolve.

In our study, we have compared:

(1) Change in CCT post-SICS and PHACO on day 7th and day 30th.
(2) BCVA between the two groups on day 30th.

It showed that in manual, small incision, cataract surgery, the mean CCT on day 7th postoperative increased from 509.098 baseline CCT to 528.9608 and on day 30th was 514.1569. Whereas in PHACO the mean CCT on postoperative day 7th increased from 518.46 baseline CCT to 533.78. And on postoperative day 30th was 524.9.

Though on the postoperative day 30th, there was a statistically significant increase in the CCT of SICS (*P* value 0.0000) and of PHACO (*P* value 0.0001), but the increase in CCT between the two groups at the end of 30th day postoperative was statistically insignificant (*P* value 0.4024). Hence, it shows that there was some endothelial cell loss leading to a change in corneal thickness in both the groups, but they were comparable.

There was a significant improvement in BCVA in both the groups. The improvement in vision was comparable between the two groups. The increase was statically insignificant (*P* value 0.1931). It, thus, concludes that there was some endothelial cell loss but not to the extent to cause visual impairment. Hence, it was proven that the visual rehabilitation in the form of BCVA was comparable between both the surgical groups.

Various studies have been published comparing the change in corneal thickness and the endothelial cell dysfunction.

Cheng *et al.*[7] also found a significant linear correlation between the increase in corneal thickness in the immediate postoperative period and percentage of cell loss, 1 and 6 months after surgery. The results suggested that corneal thickness could be a useful clinical indicator of endothelial cell loss.

Lundberg *et al.*[8] through their study concluded that the central corneal swelling at postoperative day 1 is strongly

correlated with the central corneal endothelial cell loss at 3 months and that the difference in pachymetry at postoperative day 1 is a useful way to assess the effects on the corneal endothelium exerted by the PHACO procedure.

Mencucci *et al.*[9] studied corneal endothelial changes after PHACO versus a bimanual microincision cataract surgery technique. He concluded that there was no difference in corneal thickness, corneal endothelial cell loss, or endothelial morphology between the groups at the end of 1 and 3 month.

Michaeli *et al.*[10] compared CCT and endothelial cell loss after PHACO with clear cornea and scleral tunnel incisions. They found that corneal thickness increased significantly in all measurements postoperative and returned to baseline by 3 months and there was no difference in the pachymetry change between the two study groups.Ganekal and Nagarajappa[11] compared the morphological and functional endothelial changes after PHACO versus MSICS and found that at the end of 6 weeks the endothelial changes were not statistically significant between the two groups. They concluded that the function and morphology of endothelial cells were not affected despite an initial reduction in endothelial cell number in MSICS. Hence, MSICS remains a safe option in the developing world.

The result of our study is consistent with most of the studies conducted in western countries. Our study also showed that the change in the CCT and BCVA is comparable between SICS and PHACO on day 30th postuneventful surgery. Hence, concluding that SICS and PHACO surgery are comparable in respect to visual rehabilitation, and there is no difference in the safety between MSICS and PHACO.

MSICS is still a safe and cost-effective option in the developing world. Proper case selection, diligent surgery, and adequate postoperative care are essential to maintain a clear cornea.

One of the limitations of our study is that it is not randomized. Here, only one technique of PHACO and one technique of SICS are compared; other techniques may give different results. Lastly, the corneal thickness is just a surrogate marker for endothelial cell function. Ultrasound pachymetry was taken instead of specular microscopy for documenting endothelial dysfunction. Measurements estimated by ultrasonic pachymetry are more variable. Hence, a more intensive, randomized study with large sample size is required which will help us come to a more precise conclusion.

Conclusion

The conclusions were:

(1) Both groups of surgery showed a significant increase in CCT values on postoperative day 7 indicating some endothelial cell disturbances.
(2) The endothelial cell loss in both the groups were comparable.
(3) The improvement in BCVA was statistically not so significant between the two surgical groups.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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