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ORIGINAL ARTICLE

A comparative study to evaluate the visual outcome in phacoemulsification cataract surgery and manual small incision cataract surgery with rigid PMMA IOL implantation

Manika Manika[1], Meenakshi Wadhwani[2], N. R. Gupta[3]

[1]Department of Ophthalmology, KM Medical College and Hospital, Mathura, Uttar Pradesh, India, [2]Department of Ophthalmology, Chacha Nehru Bal Chikitsalya, New Delhi, India, [3]Department of Ophthalmology, GGS Medical College and Hospital, Faridkot, Punjab, India

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Address for correspondence:
Dr. Meenakshi Wadhwani, Department of Ophthalmology, Chacha Nehru Bal Chikitsalya, New Delhi, India.
E-mail: mkgang08@gmail.com

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Abstract

Introduction: Cataract is the principal cause of treatable blindness. It is responsible for 62.6% of the total blindness. Cataract extraction is the most frequently performed surgery in patients over 65 years of age. Small incision cataract surgery (SICS) and phacoemulsification are the two most prevalent techniques of cataract surgery with almost equal success rates.

Methodology: A prospective study was conducted in a tertiary care hospital. It included 60 patients above the age of 50 years undergoing cataract surgery by phacoemulsification technique or manual SICS (30 patients in each group) with rigid PMMA IOL implantation. The patients demographic data, pre-operative and post-operative (1st week, 4th week, and 6th week) BCVA, mean astigmatism, type of astigmatism, and surgically induced astigmatism (SIA) at 6th week were recorded and compared in both groups.

Results: The mean age in Group I (phacoemulsification) was 69.63 ± 7.49 years and in Group II (SICS) was 69.30 ± 7.33 years. In Group I, there were 18 (60%) male and 12 (40%) female subjects. In Group II, there were 16 (53.33%) male and 14 (46.67%) female participants. The mean pre-operative astigmatism was 0.75 ± 0.56 D in Group I and 0.73 ± 0.52 in Group II. In Group I cases, the average amount of post-operative astigmatism was 1.98 D, 1.55 D, and 1.20 D after 1 week, 4 weeks, and 6 weeks, respectively. In Group II cases, the average amount of postoperative astigmatism was 1.86 D, 1.33 D, and 0.88 D after 1 week, 4 weeks, and 6 weeks, respectively. Fifteen (50%) participants in Group I and 16 (53.33%) in Group II have "against the rule" astigmatism. All the participants in Group I and Group II had post-operative best corrected visual acuity 6/18 or better. The mean SIA was 0.96D in Group I patients and 0.82D in Group II patients at 6 weeks. Post-operative best corrected visual acuity, mean and type of astigmatism, and SIA were almost similar in both sutureless manual SICS and phacoemulsification techniques and the difference was statistically non-significant.

Conclusion: Both phacoemulsification and manual SICS are equally effective with respect to post-operative astigmatism and BCVA. Therefore, manual SICS can be used as favorably as phacoemulsification in a developing country like India.

Introduction

Cataract is the principal cause of treatable blindness.[1] It is estimated that there is an annual incidence of 2 million cataract-induced blindness in India. National survey conducted on blindness in 2001–2002 shows that prevalence of blindness in the general population is 1.1% and in people above the age of 50 years, it is 8.5%. Cataract is responsible for 62.6% of the total blindness in the general population.[2]

Cataract extraction is the most frequently performed surgery in patients over 65 years of age.[3] Corneal astigmatism has been a by-product of cataract surgery. The vertical corneal meridian is more steeply curved than the horizontal meridian in "with the rule astigmatism" (corrected by plus cylinder axis 90°). The opposite is true in "against the rule astigmatism" (corrected by plus cylinder axis 180°). An incision of the cornea or sclera creates a gape. This gape causes corneal flattening along the meridian of the incision and steepening in the meridian 90° away.[3]

Sutures produce local tissue compression, resulting in peripheral flattening and central steepening along the meridian of the incision and flattening 90° away. The suture-induced net steepening persists for several months postoperatively. Over several years, however, progressive flattening occurs. Factors that affect the astigmatic change produced by a cataract incision include its length, meridional location, radial location (e.g., corneal, limbal, or scleral), construction, and wound damage. As a general rule, for any given incision size and construction, further the incision is from the center of the cornea, lesser is the surgically induced astigmatism (SIA). The configuration of the incision may also influence wound stability. A straight or frown shaped incision appears to induce less astigmatic change than the traditional curved incision parallel to the limbus.[4]

Cataract surgery has advanced from the method of couching to intracapsular cataract extraction to extracapsular cataract extraction to mSICS to phacoemulsification to MICS and femtosecond laser assisted cataract surgery. These advancements in cataract surgery have resulted in less tissue injury, less post-operative pain and inflammation and less SIA, and lower complication rates.

The aim of the present study is to evaluate and compare best corrected visual acuity and SIA following sutureless manual small incision cataract extraction and phacoemulsification technique with rigid PCIOL implantation.

Methodology

The study was approved by the institutional ethics board and conformed to the ethical standards stated in the 1964 Declaration of Helsinki. Informed consent was obtained from all the participants before enrolment for the study.

The study included 60 eyes of 60 patients above the age of 50 years. There were two groups consisting of 30 patients each. Group I included patients who underwent phacoemulsification with a rigid PC IOL implantation and Group II consisted of patients who underwent manual small incision cataract surgery (SICS) with a rigid PC IOL implantation. Only those patients whose functional visual disability could be attributed to cataract were included in the study. Patients with uncontrolled diabetes mellitus hypertension, history of the previous intraocular surgery, any retinal or optic nerve disease, patients with primary angle closure, and closed angle glaucoma were excluded from the study. Besides this patients with a pre-existing corneal pathology which can result in corneal astigmatism such as corneal opacities, corneal dystrophies, and keratoconus, patients having any pathological process involving limbus or sclera, patients who were not able to report for follow-up were excluded from the study.

Patients underwent a detailed pre-operative ocular examination. It included visual acuity assessment using Snellen's chart, slit lamp examination, measurement of intraocular pressure, fundus examination under mydriasis with a direct ophthalmoscope and indirect ophthalmoscope, keratometry with Bausch and Lomb Keratometer, A-scan biometry for determination of the axial length of the eye, blood pressure, and random blood sugar check-up.

Grading of visual acuity as good, borderline, and poor is according to the NPCB criteria. Difference in corneal power in steeper and flat meridian was taken as pre-operative astigmatism. The two meridians were taken at 90° and 180°. Type and amplitude of astigmatism were recorded. SRK-II regression formula was used for calculation of intraocular lens power.

Surgical technique

Mydriasis was achieved using 0.8% w/v tropicamide plus 5% w/v phenylephrine eyedrops. One drop was instilled for 3–4 times at the interval of 10 min 1 h before the surgery. Antibiotic eyedrop also instilled before the surgery. All surgeries were performed under peribulbar anesthesia by standard technique by the same surgeon.

Phacoemulsification

A 3 mm temporal clear corneal incision and side port incisions were made at 6 or 12 o'clock position. Continuous curvilinear capsulorrhexis (CCC) was performed followed by hydrodissection. Nucleus was broken into small pieces using phaco probe and was aspirated. After the nucleus, cortical matter was aspirated by bimanual technique. Clear corneal incision was extended to 6 mm and rigid PMMA PC IOL was implanted in the bag. Hydration of the side-port was done and one 10-0 monofilament ethicon suture was applied. The surgery was concluded by giving sub-conjunctival 0.5 ml of gentamycin and dexamethasone injection (prepared by mixing 2 ml each of injection gentamycin 40 mg/ml and dexamethasone 4 mg/ml).

Visco-expression technique in manual small incision cataract surgery

The globe was fixed using superior rectus bridal suture. Fornix-based conjunctival flap was made superiorly and 6 mm sized frown shaped scleral incision about half way of thickness of sclera was performed 2 mm away from the surgical limbus. A horizontal tunnel about half way the thickness of sclera was dissected up to 1–1.5 mm into the clear cornea. This tunnel was wider toward the cornea. Side pockets were made on either side of tunnel to accommodate the thickness of nucleus. Side-port entry was made at 9'o clock limbus. CCC was performed followed by hydrodissection and nucleus prolapse into anterior chamber. Nucleus was expressed out using wire Vectis. Irrigation and

aspiration of the residual cortex were done with a simcoe cannula and rigid PC IOL was implanted in the bag. Hydration of the side-port was done. Conjunctival flap was reposited back. The surgery was concluded by giving sub-conjunctival 0.5 ml of gentamycin and dexamethasone injection (prepared by mixing 2 ml each of injection gentamycin 40 mg/ml and dexamethasone 4 mg/ml).

Post-operative evaluation

Patients were discharged on antibiotic (moxifloxacin 0.5%), steroid (prednisolone 1%), and lubricating (carboxymethyl cellulose 0.5%) eyedrops. Patients were followed up on 1st week, 4th week, and 6th week postoperatively. All patients involved in the study did their follow-up visits regularly. At each visit, patient was evaluated for best corrected visual acuity, keratometry, slit lamp examination for anterior segment evaluation, and fundus examination. Type and amplitude of SIA were evaluated at 6th week. To estimate the SIA after cataract surgery, we calculated the difference between pre-operative and post-operative keratometric readings using SIA calculator version 2.1.

Statistical analysis

Data from the patient proformae were recorded and the data obtained were fed into the SPSS version 20.0 software on a monthly basis. The final analysis was done using strata 14.0. Data are presented in frequency (%) and mean with standard deviation. Association of categorical variable with demographic variable was done by Chi-square test. Continuous variables were compared by independent *t*-test and p value <0.05 was considered as statistically significant.

Results

The mean age in Group I was 69.63 ± 7.49 years and in Group II was 69.30 ± 7.33 years. Difference in age was statistically non-significant. In Group I, there were 18 (60%) male and 12 (40%) female subjects. In Group II, there were 16 (53.33%) male and 14 (46.67%) female participants. Gender distribution was comparable in both the groups.

The mean pre-operative astigmatism was 0.75 ± 0.56 D in Group I and 0.73 ± 0.52 in Group II. This difference after statistical analysis was found to be insignificant. In Group I cases, the average amount of post-operative astigmatism was 1.98 D, 1.55 D, and 1.20 D after 1 week, 4 weeks, and 6 weeks, respectively. Thus, there was progressive decrease in amount of astigmatism on all post-operative follow-ups [Tables 1 and 2].

In Group II cases, the average amount of post-operative astigmatism was 1.86 D, 1.33 D, and 0.88 D after 1 week, 4 weeks, and 6 weeks, respectively. Thus, there was a progressive decrease in amount of astigmatism on all post-operative follow-ups in this group also.

In Group I, 15 (50%) participants and 16 (53.33%) in Group II have "against the rule" astigmatism.

All the participants in Group I and Group II had post-operative best corrected visual acuity 6/18 or better than 6/18. The difference was statistically non-significant between both the groups. None of the subjects in Group I and II had post-operative best corrected visual acuity worse than 6/18. Post-operative best corrected visual acuity was similar in both sutureless manual SICS and phacoemulsification techniques and the difference was statistically non-significant.

At the end of study, that is, at 6 weeks, the mean SIA was 0.966D in Group I patients and 0.82D in Group II patients. The difference in mean SIA between both the groups was statistically non-significant [Table 3].

Discussion

Most of the times, phacoemulsification is done through a small clear corneal incision with foldable IOL implantation, but in the

Table 1: Comparison of pre-operative best corrected visual acuity and astigmatism between both groups

	Group I	Group II
Best corrected visual acuity		
Good≥6/18	0	0
Borderline 6/24–6/60	8 (26.67%)	12 (40%)
Poor<6/60	22 (73.33%)	18 (60%)
Mean astigmatism		
	0.75±0.56 D	0.73±0.52 D
Type of astigmatism		
No astigmatism	7 (23.33%)	6 (20%)
"With the rule" Astigmatism	11 (36.67%)	11 (36.67%)
"Against the rule" Astigmatism	12 (40%)	13 (43.33%)

t-value is 0.11 and *P*>0.05

Table 2: Comparison of post-operative best corrected visual acuity and astigmatism between both the groups

	Group I	Group II
Best corrected visual acuity		
Good≥6/18	30 (100%)	30 (100%)
Borderline 6/24–6/60	0	0
Poor<6/60	0	0
Mean astigmatism		
	1.20±1.13 D	0.88±0.75 D
Type of astigmatism		
No astigmatism	5 (16.67%)	4 (13.33%)
"With the rule" Astigmatism	10 (33.33%)	10 (33.33%)
"Against the rule" Astigmatism	15 (50%)	16 (53.33%)

t-value is 0.336 and *P*>0.05

Table 3: Surgically induced astigmatism at final follow-up visit

	Group I	Group II
Mean SIA	0.966±0.63 D	0.82±0.72 D

t-value is 2.003 and *P*>0.05

present study, phacoemulsification with rigid IOL implantation was performed as many of the patients visiting our department belonged to poor socioeconomic status and was not able to afford a foldable IOL that was paid in our setup.

SIA

In the present study, sutureless manual SICS (0.82 ± 0.72 D) induced slightly less astigmatism than phacoemulsification (0.966 ± 0.63 D), but the difference was statistically non-significant. This less astigmatism observed in manual SICS can be attributed to the incision location, that is, 2 mm away from limbus and incision shape, that is, frown shaped incision used as compared to clear corneal incision parallel to limbus in phacoemulsification [Table 3]. Similar finding was noted by Sarkar in 2019. They compared 5.5 mm temporal MSICS versus 5.5 mm temporal phacoemulsification. SIA reported at the end of 6-week post-operative period in their study was 0.5625 ± 0.50 D in SICS group and 0.65 ± 0.54 D in phaco group. They concluded that MSICS is less technology and machine dependent and as effective as phacoemulsification with respect to post-operative visual outcome.[5] Another study done by Patil *et al*. in 2013 found SIA of amount 1.08 ± 0.52 D in 5.5 mm temporal phaco group and 0.91 ± 0.47 D in 6 mm superior SICS group after 45th post-operative day with statistically non-significant association with the type of surgery similar to our study. They concluded that 5.5 temporal clear corneal incision and 6 mm scleral incision are comparable and either of the incision can be used for cataract surgery.[6] Devendra *et al*. in 2014 found that SIA in SICS group (0.98 ± 0.39 D) was lesser as compared to the phaco group (2.06 ± 0.52 D) at the end of 4th post-operative week. However, their difference was statistically significant ($P \leq 0.0001$).[7] Another similar study done by Birpuri and Sahni in 2018 found different results. The mean SIA, at the end of 6th post-operative week, in their SICS group was 1.48 ± 0.65 D and in phaco group, it was 1.19 ± 0.57 D and the difference was statistically significant ($P = 0.40$).[8] Gupta *et al*. in 2014 also found different results. In their SICS group, SIA was 1.37 D and in phaco group, it was 0.84 D at the end of 3rd post-operative month.[9] This contradictory result could be due to different healing properties of the wound- and surgeon-related difference in the wound construction and intra-operative manipulation.

Type of astigmatism

In temporal phacoemulsification group, 50% patients had ATR astigmatism, 33.3% patients had WTR astigmatism, and 16.8% patients had no astigmatism. In superior SICS group, 53.3% patients had ATR astigmatism, 33.3% patients had WTR astigmatism, and 13.3% patients had no astigmatism [Tables 1 and 2].

The majority of the studies comparing superior cataract surgery incisions to the temporal incisions have found that superior incisions cause more ATR shift, as superior incision cause flattening of vertical meridian and steepening of horizontal meridian and temporal incisions cause flattening of horizontal meridian and steepening of vertical meridian resulting in WTR shift. Patel *et al*. in 2020 found that 75% of patients in superior incision group had ATR-induced astigmatism and 70% of the patients in temporal incision had WTR-induced astigmatism.[10] Similar study comparing superior and temporal cataract surgery incisions done by Magdum *et al*. in 2012 found that after 3 months of surgery, 74% patients in superior incision group had ATR astigmatism and 56% patients had WTR astigmatism in temporal incision group.[11] Patil *et al*. in their study also found the WTR astigmatism in temporal clear corneal incision phaco group and ATR astigmatism in superior SICS group.[6]

In our study, the majority of the participants had "Against the rule" astigmatism in both of the groups. This contrary finding in temporal clear corneal phacoemulsification group was due to the fact that we used a single 10-0 ethicon suture to secure the wound. This suture caused flattening of peripheral cornea and steepening of the central cornea in horizontal meridian.

BCVA

In the present study, the difference of best corrected visual acuity between sutureless manual SICS and phacoemulsification techniques was non-significant. None of the cases in Group I and Group II had post-operative best corrected visual acuity worse than 6/18 at the end of 6-week post-operative [Table 1].

Similar was the finding reported by Sarkar that there were no significant differences between the extended incision phacoemulsification (98.3% of the participants) and manual small-incision cataract surgery techniques (99.92%) regarding the BCVA ≥6/18 at the end of 6-week post-operative.[5] Devendra *et al*. reported BCVA ≥ 6/18 in 90.38% of the patients in phaco group and 92.85% of the patients in SICS group at the end of 4-week post-operative.[7] Birpuri and Sahni in their study found that none of the cases had BCVA worse than 6/18 at the end of 6th post-operative week similar to our study.[8]

Conclusion

Our study shows that both extended incision phacoemulsification and manual SICS are equally effective with respect to post-operative astigmatism and BCVA. However, MSICS is relatively faster, lesser technology, and machine dependent procedure. Therefore, manual SICS can be used as favorably as phacoemulsification in a developing country like India where resources are poor and phacoemulsification machines and foldable IOLs are not available at the periphery.

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