International Journal of Medical Ophthalmology

E-ISSN: 2663-8274
P-ISSN: 2663-8266
www.ophthalmoljournal.com
IJMO 2020; 2(1): 13-16
Received: 09-11-2019
Accepted: 13-12-2019

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A comparative study of post-operative astigmatism induced by phacoemulsification and manual small incision cataract surgery

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DOI: https://doi.org/10.33545/26638266.2020.v2.i1a.24

Abstract
Background: Surgically induced astigmatism is the cause of poor postoperative vision even after uneventful cataract surgery.
AIM: The aim of the study was to compare the effect of surgically induced astigmatism in SICS and Phacoemulsification after taking the incision in the steepest meridian.
Setting: Basaveshwar Hospital, Mahadevappa rampure medical college Gulbarga, Karnataka.
Design: Prospective observational study.
Material and Methods: A total of 200 eyes of 200 patients with mean age of 62 years were included in the study. Consecutive patients with cataract were randomly assigned to undergo phacoemulsification or manual SICS by a single surgeon experienced in both techniques. Group A underwent SICS (Small Incision Cataract Surgery) and group B had phacoemulsification. Surgically induced astigmatism was analyzed by SIA software.
Statistical analysis: Non-parametric method (Mann whitney U test).
Results: The measurement of induced astigmatism was taken: dK, the net keratometric change in corneal toricity. Average dK for Group A (SICS) was +0.05 D and for Group B (Phacoemulsification) was -0.53 D. There was a difference of -0.49 D between the two groups in terms of induced keratometric astigmatism. The SICS group actually demonstrated on the average a greater iatrogenic astigmatism than the phacoemulsification group keratometrically. This is clinically or statistically significant (P<0.001).
Conclusions: Phacoemulsification induces less astigmatism than SICS. Iatrogenic astigmatism is more with SICS.

Keywords: Cataract surgery, surgically induced astigmatism, phacoemulsification, astigmatism

Introduction

Cataract surgery, today is seen as a refractive surgery. So we should be concerned not only to correct the spherical ammetropia, but also the cylindrical [1-2]. Cataract is the most important and significant cause of bilateral blindness in senile age group, both in India as well as on a global scale. Modern cataract surgeries with intraocular lens (IOL) have become one of the safest, most successful, simple, and consistent and most frequently performed surgeries. Small incision cataract surgery (SICS) is gaining popularity in developing countries as an inexpensive alternative to phacoemulsification [3]. SICS and phacoemulsification have advantages like early visual rehabilitation, less induced astigmatism and no suture-related complications as wound constriction and closure. The surgeries are gaining attention and importance.

With astonishing advances in technology and predictability of surgery, expectations of both surgeons and patients have increased. Surgeons aim to meet the individual patient's refractive goal and patients, expect good vision without the spectacles immediately. The making of the incision in the steepest meridian leads to corneal flattening and reduces astigmatism. Although small, the magnitude of astigmatism caused by incision depends on the size and its location [4, 5]. The surgically induced astigmatism is greatly influenced by the incision taken in different meridians [6]. Alpins and Goggin, [2] and Holladay *et al*., [7] have studied the effect of SIA on the magnitude of pre-existing. Astigmatism by taking the incision on the steepest pre-operative calculated meridian. In 1975, Jaffe and Clayman were first to report surgically induced astigmatism after cataract surgery.

Postoperative astigmatism is affected by various factors such as preoperative astigmatism, location, type, size, closure, healing of the surgical incision, amount of scleral cauterization performed, type of suturing material used and its placement, position of IOL, and postoperative use of steroids, as these have effects on corneal curvature [8].

In 1975, Jaffe and Clayman first reported the exact measure of change induced by surgery, the SIA [9]. Now MS Excel sheet-based programs are available to calculate SIA. One such program was used in our study to determine SIA. In our study we have aimed to evaluate the magnitude of surgically induced astigmatism after SICS and phacoemulsification in 100 consecutive patients based on the incision in the steepest meridian on the magnitude of the pre-existing astigmatism.

Materials and Methods

This was a prospective, interventional, observational, follow-up study carried out from1st November 2018 to 30th December 2019. A total of 200 eyes of 200 consecutive patients with a mean age of 60 were included in the study which was conducted in ophthalmology department in a tertiary eye care center.

The cases were randomly divided into two groups.100 patients underwent SICS and another 100 patients underwent phacoemulsification. Informed consent was obtained from all the patients enrolled in the study.

The inclusion criteria were uncomplicated senile cataract, patients with preoperative astigmatism between 0.5D -1.5 D, good fixation, and cataracts up to grade 3 nuclear sclerosis. Higher grade of nuclear sclerosis was excluded to keep uniformity in the two groups.

Exclusion criteria were complicated cataracts, traumatic cataract, cataract associated with pterygium, corneal opacity, the eyes which had undergone C3R or LASIK and the eyes which had undergone previous ocular surgeries.

Preoperative assessment included medical history, refractive history, visual acuity, intraocular pressure, sac syringing, and examination of anterior and posterior segments. A thorough posterior segment evaluation was done. The grading of nucleus was performed according to Lens Opacification Classification System III (LOCS III). Keratometry was performed preoperatively and postoperatively by using Bausch and Lomb Keratometer. SRK II formula was used to calculate the IOL power [1].

Surgical technique: All cases were operated under local peri-bulbar anesthesia, following aseptic precautions.

Group A underwent SICS. The incision site was taken in the steepest meridian on the magnitude of pre-existing astigmatism which was evaluated by keratometric reading. After resection of the conjunctiva (Fornix based), 1-2mm posterior to the surgical limbus, a 6-6.5mm frown incision was taken. Self-sealing tunnelling done. Anterior chamber was entered using 3.2mm keratome. After maintaining the anterior chamber, capsulorhexis done. Hydrodissection done. Nucleus was dialed in the anterior chamber and delivered using phaco sandwich technique. Irrigation and aspiration done. Insertion of posterior chamber PMMA non-foldable IOL in the bag. In anterior chamber thorough irrigation and aspiration done to remove the viscoelastic substance. Final re-apposition of the conjunctival flap done. Sub-conjunctival antibiotic and steroid injected.

Surgical technique of group B–Patients underwent phacoemulsification under peribulbar block. Side ports are made depending on the incision site. Modified cystitome introduced through one of the side ports and continuous curvilinear capsulorrhexis done. A clear corneal 3.2mm incision in the steepest meridian on the magnitude of pre-existing astigmatism which was evaluated by keratometric reading. Hydro delineation and Hydro dissection done. Nucleus was emulsified by using Stop and chop technique. Thorough irrigation and aspiration done. Foldable PMMA posterior chamber IOL loaded in the injector and the injected in the anterior chamber. PCIOL dialed in the anterior chamber. Irrigation and Aspiration done. Side ports hydrated. Sub-conjunctival antibiotic and steroid injected. Eye padded and bandaged.

Post-operatively antibiotic and steroid combination eye-drops were given 10 times for 1 week, 6 times per day for next 3 weeks and 4 times a week 3 times a week 2 times a week and 1 time a week and then stopped.

Postoperative assessment: Post-operative assessment was done on the 1st, 7st, and 30th post-operative days. At each visit, measurement of visual acuity, retinoscopy, anterior segment examination, fundoscopy, and keratometry were done. The course of postoperative astigmatic changes was determined by keratometry performed with a standard calibrated keratometer (Bausch and Lomb). Corneal clarity, wound integrity, and PCIOL placement were carefully examined on postoperative follow-ups.

SIA was calculated by using SIA calculator version 3.1. [10] SIA was interpreted in magnitude [diopter (D)] and axis (degree). Data analysis was done using the Statistical Package for the Social Science (SPSS) Version 15 for Windows. The standard deviations pre-and postoperative were statistically analyzed.

In this study, 100 eyes of 100 patients were included and underwent cataract surgery. They were categorized as group A: SICS in 100 eyes and group B: 100 eyes underwent phacoemulsification. The results were analyzed and the following observations were made. All patients had cataracts and astigmatism greater than 0.50 D.

The measurement of induced astigmatism were taken: dK, the net keratometric change in corneal toricity. The dK value was obtained by subtracting preoperative keratometry from postoperative keratometry. In this study, we tested patients at three and six weeks postoperatively.

No wound related complications occurred. After tabulation, average dK for Group 1 was +0.50 D and average dK for Group 2 was -0.53 D.

This is clinically or statistically significant (P <0.001).

Group A +0.05, SD 0.31

Group B -0.53, SD 0.65

In comparison

According to non-parametric method (Mann whitney U test) Z = 5.387 (p<0.001) Due to lot of variations in outcome we are not following the gaussian distribution.

Comparison of the steepest meridian incision site,

In group A -0.49, SD = 0.76

In group B -0.78, SD = 0.46

According to non-parametric method (Mann whitney U test)

Z = 2.772 (p<0.006)

The study shows a significant difference proving group B producing less surgically induced astigmatism than group A.

Table 1: Comparison of uncorrected postoperative visual acuity on 30th postoperative day in the study groups

Visual Acuity	Group A	Group B	Total
6/60 – 6/24	10	00	10
6/18 – 6/12	20	40	60
6/9 – 6/6	60	70	130
Total	100	100	200

According to the results of visual outcome, group B patients had a good visual acuity after 30th day post-operatively as compared to group A. So, by taking the incision on the steepest meridian in phacoemulsification, patients had better visual acuity.

Table 2: Comparison of SIA on postoperative 30th day in the study groups

Post-operative day	SIA in group A	SIA in group B	Z value	P value
30th day	+0.05	-0.53	5.387	<0.001

Surgically induced astigmatism in group B was less compared to group A, showing phacoemulsification induced less post-operative astigmatism.

Discussion

Patients undergoing cataract surgery expect clear vision and less dependence on spectacles. To attain this goal, SIA has to be reduced. Modern cataract surgery aims at this modification. Reduction of SIA was the main aim of this study. All were statistically significant. Astigmatism was assessed by using keratometry readings and SIA was calculated with SIA Soft Microsoft Excel sheet calculator.

The change in the corneal curvature is responsible for SIA and the astigmatic refractive error. Uncorrected astigmatism can cause blurred images and glare. These effects can create patient discomfort and dissatisfaction with otherwise uneventful cataract surgery [11]. Length of incision and site are the two major factors affecting the induced astigmatism.

Many studies document temporal clear corneal incision of 2.8, 3.2, and 4.0mm, which induce very low astigmatism and are suitable for astigmatically neutral eyes and those with low preoperative WTR astigmatism. So, horizontal meridian incisions have an advantage of less SIA as they are away from the visual axis [12, 13].

The hypothesis that guided the study was, there is no significant difference in SIA induced by SICS and phacoemulsification. We used a real, clinical value obtained by final postoperative refraction as the end point. While surgically induced astigmatism is commonly thought to be related to surgical technique, it is easy to make misleading assumptions. When we began this investigation, we were convinced that a smaller incision would produce postoperative astigmatism that would more closely emulate the preoperative value. A prospective, consecutive series of cataract extractions using planned. SICS in the first 100 cases and Phacoemulsification in another 100 cases was studied. Phacoemulsification induced less astigmatism than SICS. The difference was statistically significant (P=0.006 for dK at 1 months). In a study conducted by Samuel Lear Pall in, that extra capsular cataract extraction induced less SIA as compared to phacoemulsification. The result was not statistically significant [13].

In another study conducted, stated that it is possible to achieve negligible or low astigmatic outcome in eyes with pre-existing with or against the rule astigmatism by pre-determining the steepest meridian [14].

In a study conducted by Alexandre Denoyer *et al*., they concluded corneal elasticity plays a crucial role in surgically induced refractive changes. They confirmed that MICS resulted in a decrease in SIA as compared to SICS [15].

On comparing the postoperative SIA on day 7 with SIA on 30th day postoperative, there was statistically significant difference and a gradual decrease in SIA was seen.

In our study we found that taking clear corneal incision on the steepest meridian in phacoemulsification produced less SIA as compared to SICS. This suggested that the wound healing was fast and was stabilizing till the 30th postoperative day. For a variety of reasons, Phacoemulsification will be the treatment of choice for cataract in the foreseeable future. Phacoemulsification is still not the choice because SICS is less technology dependent; hence, it is less expensive and more appropriate for treatment of advanced cataracts prevalent in the developing world [6]. Phacoemulsification is technically more challenging and requires the need for infrastructure.

Conclusion

Cataract surgery incision causes flattening of the cornea in the same meridian and reduces existing astigmatism if used in proper site. The purpose of the study is to see the beneficiary effect of an incision placed on the steepest meridian in controlling/ lowering the astigmatic outcome in eyes with pre-existing astigmatism and comparing effect of incisions at different sites. Thus it has been proposed that the use of incisions in the steepest meridian of the cornea helps to correct these cylindrical refractive errors. Superior incision has twice the astigmatic impact of temporal incision due to the fact that temporal limbus is further away from the visual axis than superior limbus. Placing the incision on the steepest meridian leads to a significant amount of corneal flattening in that meridian and a corresponding steepening in the opposite meridian [1]. Phacoemulsification leads to less SIA in comparison to SICS.

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