ORIGINAL ARTICLE

Corneal topography and astigmatism evaluation following small incision cataract surgery and phacoemulsification

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ABSTRACT

BACKGROUND: Cataract is the commonest cause of correctable dimness of vision among adults. Over two-third of the population over age 60 has a visual problem due to cataract; over a million people undergo a cataract removal surgery annually. Using modern methods, poor vision from cataracts can be improved 98% of the time.

This study aims to evaluate corneal topographical changes in corneal curvature following phacoemulsification (PHACO) and following small incision cataract surgery (SICS), to compare mean corneal astigmatism following different site and size of incision, and to estimate induced astigmatism and its association with refraction. **MATERIALS AND METHODS:** This is prospective study of 100 patients underwent cataract extraction in 50 with PHACO and 50 with SICS with PC IOL implantation in our eye hospital during the period 2008 to 2011. The patients of cataract were randomly selected from OPD and operated by single consulting surgeon. Post-operative assessment was done at 1, 3, 6, 12, and 24weeks, at each visit patients were evaluated for corneal topography and induced astigmatism. **RESULTS:** In our study percentage of female patients (70%) was significantly higher in SICS compare to PHACO where male dominated (64%). Overall study subjects had 53% females. The Keratometry (K) topography was inversely proportioned to AL whereas Intra ocular lens (IOL) power remained in the range of about 20.50 to 22.50 D in all cases due to neutralizing effect of K on AL. The post-operative study of mean astigmatism showed that, in both the groups there was a trend of decreasing astigmatism over a period of time but the decrease was more in PHACO as compare to SICS. **CONCLUSION:** From this study we concluded that the PHACO wound relatively stable right from beginning and initial induced astigmatism relatively low. Keratometry (K) topography was inversely proportioned to AL whereas Intra ocular lens (IOL) power remained in the range of about 20.50 to 22.50 D in all cases due to neutralizing effect of K on AL.

The post-operative study of mean astigmatism showed that, in both the groups there was a trend of decreasing astigmatism over a period of time but the decrease is more in PHACO as compare to SICS.

Keywords: Corneal Topography, Astigmatism, Small Incision Cataract Surgery, Phacoemulsification

INTRODUCTION

Cataract is the most common cause of correctable dimness of vision among adults. Over two-third of the population over age 60 has a visual problem due to cataract; over a million people undergo a cataract removal operation annually. Today a cataract can be surgically removed without discomfort. Using modern methods, poor vision from cataracts can be improved 98% of the time.

Although cataract surgery has been performed since ancient times, the last half-century has seen remarkable refinements of the procedure. More advances in lens removal has occurred and corneal astigmatism has decreased as shown in descending order conventional followed by sics followed by phacoemulsification.

In 1957, Barraquer of Spain used alpha-chymotrypsin to enzymatically dissolve the zonules for removal of the lens. In 1961, Krawicz of Poland introduced Cryo-surgery that removed the lens with a tiny probe attached by freezing a small area on the surface of the cataract. In the late 1960s, Charles Kelman of New York developed a technique for emulsifying the lens contents using ultrasonic vibrations and aspirating the emulsified cataract. Now a days, PHACOEMULSIFICATION & SICS are most commonly performed techniques for cataract surgery with iol implantation.

Corneal topography

Corneal topography, also known as photokeratoscopy or videokeratography, is a

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non-invasive medical imaging technique for mapping the surface curvature of the cornea, the outer structure of the eyes. Since the cornea is normally responsible for approximately 70% of the eye's refractive power its examination by corneal topography is of critical importance in determining the quality of vision.The computerised topography was introduced few year ago providing for the first time both qualitative and quantitative information about the cornea. In 1896, Allvar Gullstrand incorporated the disk in his ophthalmoscope, examining photographs of the cornea via a microscope and was able to manually calculate the curvature by means of a numerical algorithm. "The flat field of Placido's disk reduced the accuracy close to the corneal periphery and in the 1950s the Wesley-Jessen company made use of a curved bowl to reduce the field defects. The curvature of the cornea could be determined from comparison of photographs of the rings against standardized images. In the 1980s, photographs of the projected images became hand-digitized and then analysed by computer. Automation of the process soon followed with the image captured by a digital camera and passed directly to a computer.

Corneal astigmatism

Astigmatism is the result of an inability of the cornea to properly focus an image onto the retina which focuses in different meridian. Thomas young (1793) proved the existence of astigmatism in his own eyes by observing a difference in focus between vertical and horizontal lines. This defect was corrected by cylindrical lensby Sir George Biddeiel Airy. Physiologically the horizontal meridian of the cornea is flatter than vertical meridian which is probably due to pressure of lids which produce physiological astigmatism about 0.25 D.Marin amat found that the cornea is normally almost sphericalexcept that the central cornea is flatter than the peripheral. There is evidence that physiological astigmatism tends to increase to a very slight extent with advancing age , but in older age it tend to disappear or even reverse itself for changed by lenticular astigmatic changes. Following factors influence the amount of astigmatism postoperatively after cataract surgery.

1. Type of incision& surgery
2. Site of incision
3. Size and material of sutures
4. Depth& Tightness of sutures
5. Number of sutures

Here, in this study we measured postoperative induced astigmatism by subtraction method disregarding the axis.Subtraction method-diff. between preoperative and postoperative astigmatism by topography gives net induced astigmatism.

Cataract surgery in brief

Small Incision Cataract Surgery: The purpose of ECCE is to restore clear vision by removing a clouded or opaque lens and replacing it with an IOL. Cataract surgery is among the oldest recorded surgical procedures; there are references to cataract surgery in the Code of Hammurabi in 1750 b.c. and in the treatises written around 600 b.c. by Susruta, a famous surgeon from India. In the ancient world, lenses damaged by cataracts were dislocated rather than removed in the strict sense; the surgeon used a lance to push the clouded lens backward into the vitreous body of the eye. This operation, known as couching, was standard practice until the mid-eighteenth century.

The first extracapsular extraction of a cataract was performed by a French surgeon named Jacques Daviel in 1753. Daviel removed the lens through a fairly long incision in the cornea of the eye. In 1865, the German ophthalmologist Albrecht von Graefe refined the operation by removing the lens through a much smaller linear incision in the sclera of the eye. After von Graefe, however, intracapsular extraction gradually became the favoured method of cataract removal even though it left the patient without a lens inside the eye. The two inventions that made extracapsular extraction preferable again were the operating microscope and the intraocular lens. Although phacoemulsification was first introduced in 1967, it was not widely accepted at first because it requires special techniques that take time for the surgeon to learn as well as expensive specialized equipment. As of 2003, phacoemulsification is now performed more often in the United States and Europe than "standard" ECCE. The manual expression technique, however, is still widely used in

developing countries with large numbers of patients with eye disorders and limited hospital budgets.

Phacoemulsification: Phacoemulsification is a variation of extracapsular cataract extraction, a procedure in which the front portion of the capsule called anterior capsule removed & then lens is removed with ultrasonic vibrations & aspiration of lens material by phaco probe attached with phaco machine. Formerly the most popular cataract surgery, the older method of extracapsular extraction involves a longer incision, about 0.4 in (10 mm), or almost half of the eye. Recovery from the larger incision extracapsular extraction also requires almost a week-long hospital stay after surgery and limited physical activity for weeks or even months. Phacoemulsification has changed the era of cataract surgery. Most surgeons prefer a certain technique for the procedure, although they might vary due to the cataract's density and size. The variations on the phaco procedure lie mostly on what part of the nucleus the surgeon focuses on first, and how the cataract is emulsified. Some surgeons prefer a continuous "chop," while others divide the cataract into quadrants for removal. One procedure, called the "phaco flip," involves the surgeon inverting and then rotating the lens for removal. Advances in technology also may allow for even smaller incisions, some speculate as small as 1.8 mm and phaconit0.9 mm. This study aims to evaluate corneal topographical changes in corneal curvature following phacoemulsification and following small incision cataract surgery, to compare mean corneal astigmatism following different site and size of incision, and to estimate induced astigmatism and its association with refraction.

MATERIALS AND METHODS

This is prospective study of 100 patients underwent cataract extraction in 50 with Phacoemulsification (Phaco) and 50 with Small Incision Cataract Surgery (SICS) with PC IOL implantation under peribulbar block anesthesia in our eye hospital during the period 2008 to 2011. The patients of cataract were randomly selected from OPD and operated by single consulting surgeon.

Pre-operative assessment

1. Visual acuity
2. Slit lamp examination to note
   a) corneal transparency
   b) depth of AC
   c) state of iris/pupil
   d) morphology and type of cataract
3. Tonometry to rule out high IOP
4. Fundus to rule out posterior segment pathology
5. Keretometry: corneal curvatures in vertical and horizontal meridians were measured with the help of Bausch and Lomb keratometer.
6. A-scan for Axial Length and IOL power by SRK formula.
7. Corneal topography – K1 K2 astigmatism.

Full examination of patients which selected for study, patient's name, age, sex, birth date were entered and videokeratographic picture was taken and colour topography map was examined for K1 K2 astigmatism noted. Then cataract surgery was done by SICS or Phaco.

Post operative assessment

Done at 1 week, 3 week, 6 week, 3 month, 6 month at each visit patients were evaluated for corneal topography for keratometry& net induced astigmatism . Routine postoperative examination including visual acuity,slit lamp examination etc done on all follow up for proper post operative healing.

Chi-square (χ^2) and Student*t*testswere used to compare variables and tests were considered significant when P-Value <0.05.

Observation and Discussion:

This study has 100 cases of cataract extraction, 50 by phacoemulsification (PHACO) through 3 to 3.2 mm clear corneal superior or superotemporal incision and 50 by small incision cataract surgery (SICS) through 6 to 6.5 mm scleral tunnel incision by single senior surgeon.

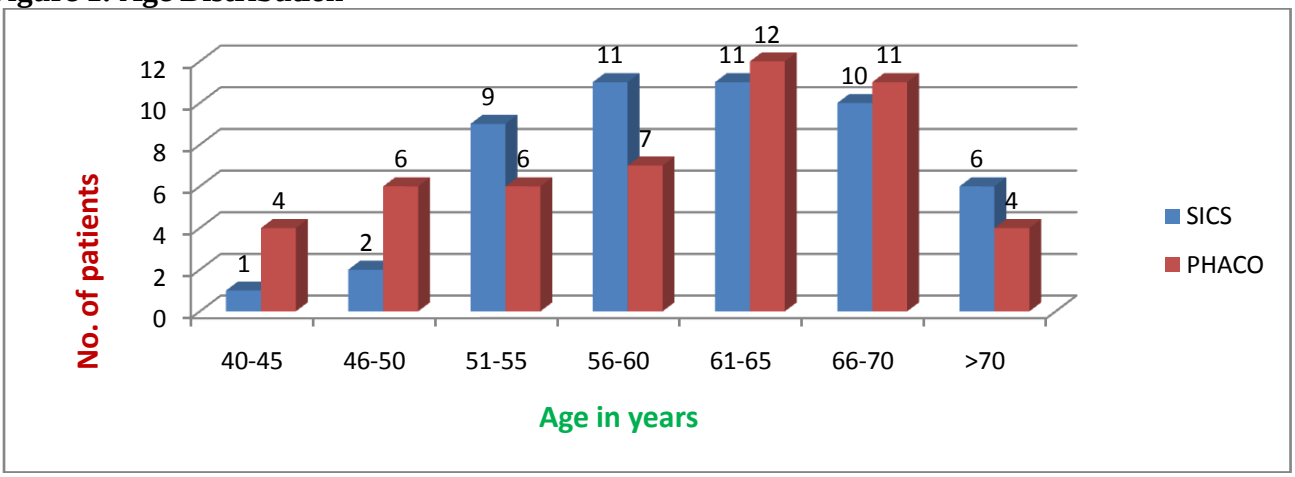
In our study percentage of female patients (70%) was significantly higher in SICS compare to PHACO where male dominated (64%). Overall study subjects had 53% females (Table 1).

Table 1: Sex distribution

CATARACT SURGERY	SICS	PHACO	TOTAL
MALE	15 (30%)	32 (64%)	47 (47%)
FEMALE	35 (70%)	18 (36%)	53 (53%)

In both type of surgeries, approximately 60% of patients were in age group of 56-70 years (Figure 1).

Figure 1: Age Distribution



Average axial length (AL) of all patients together was 22.71mm. We divided the subjects in two groups—Group 1 where patients AL was less than average AL and Group 2 where patients AL was greater than average AL. 56% of patients were in Group 1. The Keratometry (K) topography was inversely proportioned to AL whereas Intra ocular lens (IOL) power remained in the range of about 20.50 to 22.50 D in all cases due to neutralizing effect of K on AL (Table 2).

Table 2: Axial length distribution according to K Topography and IOL Power

Axial Length	Average K (in D)Topography	Average IOL power(in D)	No of patients
Group 1	45.40	22.98	56
Group 2	44.04	20.87	44

Mean astigmatism at 1st post-operative week in SICS patientswas 2.23 D and in PHACO 1.44 D which gradually decreases after 6 months to 2.06 D in SICS and 0.84 D in PHACO.

The post-operative study of mean astigmatism showed that, in both the groups there was a trend of decreasing astigmatism over a period of time but the decrease was more in PHACO as compare to SICS (Table 3, Figure 2).

Weale et al study showed that during the first postoperative month photokeratometric measurements showed rapid changes in astigmatism associated with large changes in the direction of the axis. Thereafter astigmatism against-the-rule predominated. Data from the small group of patients who underwent surgery in which the technique of phacoemulsification was used show that the smaller changes in corneal curvature are attributable to the smaller incision size and reduced number of sutures or no sutures. There is no definite increasing or decreasing pattern of induced astigmatism with progress of age but PHACO wound is relatively more stable than SICS and induced astigmatism was almost double in SICS as compared to PHACO (Table 4).

Table 3: Mean Cylinder SICS VS Mean Cylinder PHACO

Duration	Mean cylinderSICS	Mean cylinderPhaco
Pre op	1.31	1.29
1st week	2.23	2.06
3rd week	1.91	1.54
6th week	1.79	1.40
3rd month	1.64	1.04
6th month	1.44	0.84

Figure 2: Comparative study of change in mean Astigmatism following SICS & PHACO

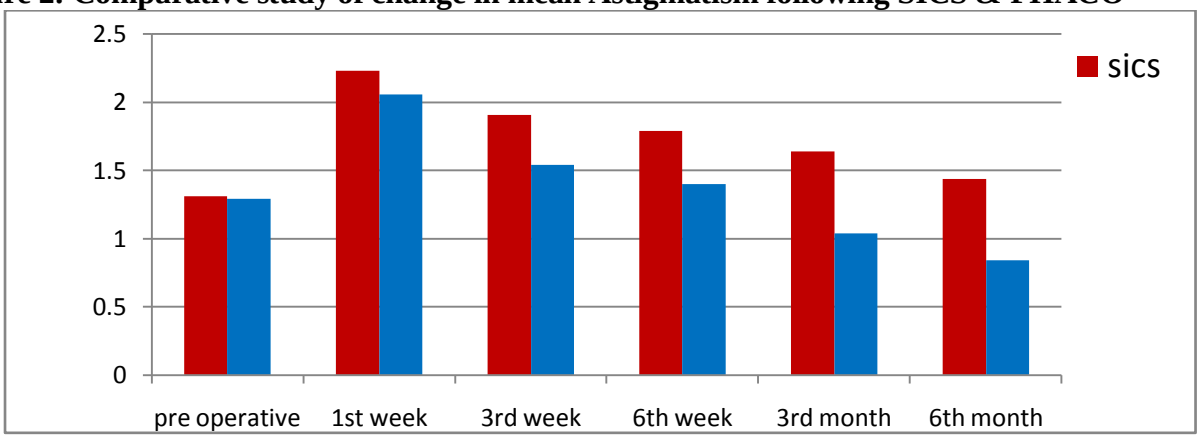


Table 4: Comparative study of post-operative induced Astigmatism following SICS & PHACOEMULSIFICATION

Surgery	Induced astigmatism
SICS	1.19
Phaco	0.60

Hayashi K et al found in his study that the mean induced corneal astigmatism was significantly less in micro-incision surgery (MICS) group than small-incision surgery (SICS) group,1 week postoperatively and subsequently.

The averaged difference map on videokeratography showed focal corneal flattening corresponding to the incision and coupled steepening around the flattened area 2 days postoperatively in both groups. The flattening and steepening gradually reduced to virtually the preoperative shape by 8 weeks; the changes were significantly less in the MICS group than in the SICS group.

In Watson A et al study, 50 eyes had implantation of a 7 mm diameter optic intraocular lens (IOL) following conventional extracapsular cataract extraction (ECCE) with a 10 mm corneal incision. Forty-seven eyes were implanted with a 5 x 6 mm optic IOL through a 5 mm scleral incision after phacoemulsification. Uncorrected visual acuity of 6/9 or better was achieved in 25% of eyes on the first day following phacoemulsification, 36% at 1 week and 57% at 12 weeks. These results were significantly better than those following ECCE. Less astigmatism was induced by phacoemulsification than extracapsular surgery, measured at all post-operative time intervals

CONCLUSION

From this study we concluded that induced astigmatism after cataract surgery with Phacoemulsification is significantly lower than Small Incision Cataract Surgery. The post-operative study of mean astigmatism showed that, in both the groups there was a trend of decreasing astigmatism over a period of time but the decrease is more in PHACO as compare to SICS.

The Keratometry (K) topography was inversely proportioned to AL whereas Intra ocular lens (IOL) power remained in the range of about 20.50 to 22.50 D in all cases due to neutralizing effect of K on AL. Induced astigmatism in both groups showed rapid decline upto 6 weeks than relatively stable.PHACO wound relatively stable right from beginning and initial induced astigmatism is relatively low.

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