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ORIGINAL ARTICLE

Astigmatism in Straight and Frown Incision in Small Incision Cataract Surgery: A Comparative Study

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ABSTRACT

Introduction: Blindness due to cataract presents an enormous problem especially in developing countries like India, not only in terms of human morbidity but also in terms of economic loss and social burden. The cataract surgeon of today is challenged to control the sphere as well as the cylinder of the refraction after surgery. Small incision cataract surgery (SICS) is now the method of choice in many parts of the world. This present study has been carried out with the aim to compare the postoperative corneal astigmatism between the two groups of patients undergoing SICS with posterior chamber intraocular lens (PCIOL) implantation with two difference types of incisions, i.e., frown and straight.

Material and methods: A prospective study was carried out in 60 patients enrolled from the Department of Ophthalmology of Pondicherry Institute of Medical Sciences who underwent SICS with superiorly placed straight and frown incision with PCIOL (each group consisting of 30 patients) during the period from May 2005 to October 2006.

Results: In this study, 60 patients having senile cataract in the age group of 50 to 75 years were studied. Out of these, the majority were in the age group of 60 to 64 (28.33%) years and only 26.66% were more than 70 years. The male:female ratio was 1:1. In our study, we found that frown incision had significantly better ($p < 0.001$) mean net astigmatism as compared with the straight incision.

Conclusion: We conclude that small incision size and absence of suture are the most important factors that contribute to less astigmatism and faster stabilization of SICS, where phacoemulsification cannot be performed. The duration for stabilization of postoperative astigmatism in straight incision group is 6 weeks, whereas it is 3 weeks in frown incision. Frown superior incision has got added advantage of early wound stabilization than straight incision, allowing the patient to resume their daily activities at an early stage. Superior incision group (both frown and straight) had increased amount of with-the-rule (WTR) astigmatism which later shifted to against-the-rule. There was a significant difference in net astigmatism between frown and straight. Postoperative astigmatism also depends on preoperative astigmatism. Patients with preoperative WTR benefited from superior incision cataract surgery.

Keywords: Astigmatism, Cataract, Keratometry.

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INTRODUCTION

Any opacity in the lens or its capsule whether developmental or acquired is called cataract.[1] The term cataract was introduced by *Constantinus Africanus*.[2]

Blindness due to cataract presents an enormous problem, especially is developing countries like India not only in terms of human morbidity but also in terms of economic loss and social burden. Cataract has been documented to be the most significant cause of bilateral blindness in India where vision <20/200 in the better eye on presentation is defined as blindness.[3-8] In India, cataract has been reported to be responsible for 50 to 80% of the bilateral blindness in the country.[3-8]

The "Cataract incision" is the most common refractive procedure performed today. From submillmeter cataract surgery days of Sushruta (couching) in the 600 BC to the present-day submillmeter cataract surgery, we have probably come a full circle.[9]

The cataract surgeon of today is challenged to control the sphere as well as the cylinder of the refraction after surgery. The goal of present-day cataract surgery is to provide clear unaided vision soon after surgery. With the popularity of intraocular lens implantation surgery and availability of accurate intraocular lens power calculation methods, the chief impediment to early visual rehabilitations is postoperative astigmatism.

Astigmatism was accepted for decades as the undesirable but inevitable consequence of cataract surgery. Modern cataract surgery has dramatically reduced the refractive error in the form of astigmatism induced by large incision cataract surgeries.

The alterations in corneal curvature in the early postoperative period are primarily attributable to the surgical procedure. The cataract incision and its closure can have a profound effect on astigmatism and therefore the refractive status postoperatively. Reduction in astigmatism helps in obtaining a more rapid visual rehabilitation, greater patient satisfaction, and better optical results free from cylinder distortion and asthenopic symptoms.

Two discoveries, which have revolutionized the field of cataract surgery, are the intraocular lens implant and phacomulsification. With these, the concept of cataract surgery has changed from just restoring vision to restoring quality of vision and patient comfort within a short period.

Small incision cataract surgery (SICS) is now the method of choice in many parts of the world. Manual-phaco (SICS) techniques are becoming popular in developing countries. Phaco has its own limitations like lack of training facilities, long learning curve, cost and maintenance of the machine, and serious complications (caused by the beginners). Small incision cataract surgery provides best of both, i.e., the simplicity of extracapsular cataract extraction (ECCE) and the excellence of Phaco.

The SICS has two types of incision based on the site and anatomical location:

1. Scleral tunnel
2. Clear corneal

The use of the concept of incision *funnel* is such that an incision constructed within this imaginary *funnel* is astigmatically neutral. The scleral tunnel incision could be of three types:

1. Curvilinear
2. Straight
3. Frown

A self-sealing scleral tunnel incision creates a very stable wound that can be constructed to induce varying amounts of corneal steepening or flattening in the incision meridian (Fig. 1).[10]

This present study has been carried out with the aim to compare the postoperative corneal astigmatism between the two groups of patients undergoing SICS with posterior chamber intraocular lens (PCIOL) implantation with two difference types of incisions, i.e., frown and straight.

MATERIALS AND METHODS

A prospective study was carried out in 60 patients enrolled from the Department of Ophthalmology of Pondicherry Institute of Medical Sciences, Puducherry, India, who underwent SICS with superiorly placed straight and frown incision, each group consisting of 30 patients during the period from May 2005 to October 2006.

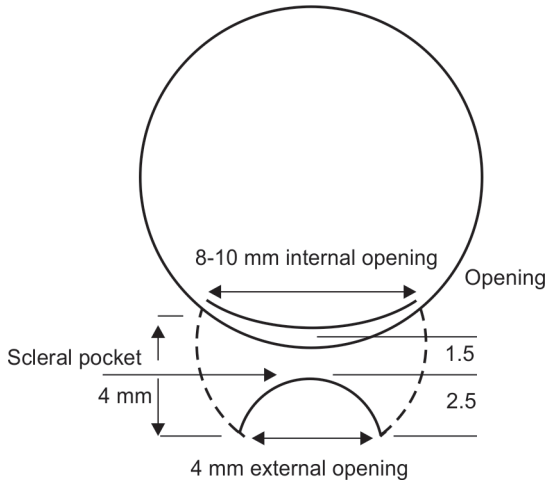


Fig. 1: The sclera tunnel

Selection of patients was carried out as follows. The patients admitted for cataract surgery between the age group of 45 to 75 years were only considered for the study. Any patients with the preexisting corneal disease were excluded. Any previous history of wearing spectacles was elicited.

Inclusion Criteria

- All patients who have a senile cataract in the age group of 45 to 75 years.
- Patients with no other cause for defective vision other than cataract.
- Patients with no history of previous ocular surgery in the operating eye.
- Preoperative astigmatism less than 1 D.

Exclusion Criteria

- Patients with other ocular pathology including complicating cataract.
- Patients having operative complications (nucleus drop, posterior capsular rent) and systemic disorder (diabetes mellitus, hypertension).
- All patients with preoperative astigmatism of more the 1 D.
- Cases with premature entry.
- Cases where valve could not be formed properly either due to deep or superficial incision.
- Cases in which suture has been applied.

Preoperative assessment was done which included detailed history taking and routine investigations for intraocular surgery like recording of vision with Snellen's (or) E-chart, recording intraocular pressure with Schiotz

tonometer, assessing the patency of duct, dilatation of pupil, refraction and fundus examination, preoperative keratometery with Bausch and Lomb keratometer. A scan biometry and intraocular lens (IOL) power calculation using SRK II (modified Sanders–Retzlaff–Kraff II regression) formula, slit lamp examination for anterior segment evaluation was done. Evaluation of status of other eye was done. Systemic parameters like postprandial blood sugar, systemic blood pressure, ear, nose, and throat and dental examination to rule out focal sepsis were done. All patients selected for surgery were admitted in the ward 1 day before surgery. The eyelashes were clipped and antibiotic drops were applied.

Surgical Procedure

Totally, 30 cases of each superior straight and superior frown incision SICS with PCIOL surgery were performed by a single surgeon at Pondicherry Institute of Medical Sciences, Puducherry, India. Informed consent was obtained from all the patients. These patients were taken up for comparative study.

After separating lids with a speculum and taking superior rectus bridle suture, a frown/straight incision 5.5 to 6 mm long (as measured by Castroviejo scleral caliper) in ½ thickness of sclera was made about 1.5 to 2 m posterior to limbus at 12 o'clock. The anterior chamber was deepened with viscoelastic. After completion of surgery and PCIOL implantation, a subconjunctival injection of 0.5 and 0.5 cc gentamicin was given, followed by repositioning of conjunctiva over wound. No sutures were used to close the incision.

Patients who developed any complications arising during the surgery or during the postoperative period were excluded from the study.

Postoperative management and follow-up consisted of patients receiving a topical antibiotic steroid drop, which was tapered by 45 days. Patients were subjected to slit lamp examination on the first postoperative day and discharged on third postoperative day. The visual acuity and keratometry readings were taken on the day of discharge and at the follow-up period, i.e., at 1st week, 3rd week and 6th week postoperatively. The findings were tabulated on the specially prepared pro forma.

Surgically induced astigmatism (SIA) was calculated by scalar analysis method. In this method, SIA was calculated by subtracting the preoperative keratometric cylinder from that measured at each postoperative examination. Steep meridians between 46° and 134° were considered as with-the-rule (WTR) and those with steep meridians less than 46° and greater than 134° , against-the-rule (ATR). Preoperative or postoperative WTR cylinders were called positive; preoperative or postoperative ATR cylinders were called negative. For example, an eye with 1 D of preoperative WTR cylinders that results in 1 D of postoperative ATR cylinders has been altered by a net 2 D astigmatism shift toward ATR.

The results were tabulated. Statistical analysis was done in EPI-Info software and t-test was applied. Statistical significance was taken as p-value < 0.0.05.

RESULTS

In this study, 60 patients having senile cataract in the age group of 50 to 75 years were studied. Out of these majority were in the age group of 60 to 64 years (28.33%) and only 26.66% were more than 70 years. The male:female ratio was 1:1.

The profile of preoperative astigmatism revealed corneal astigmatism was not present in 28.3% patients. The WTR astigmatism was in 38.33% patients; ATR astigmatism was in 33.33% patients. The WTR was more frequent (Table 1).

The observation of astigmatism in diopters preoperatively revealed 48.33% had astigmatism ≤0.25 D, 35% has astigmatism range from 0.26 to 0.50 D, 15% had astigmatism range from 0.51 to 0.75 D, and 1.6% had astigmatism range from 0.76 to 1.00 D (Table 2). The course of postoperative astigmatism in relation to preoperative status in patients with frown incision revealed majority showed shift toward WTR astigmatism in the first postoperative week, then the ATR astigmatism increases progressively up to 3 weeks and starts stabilizing at 3 weeks. However, in straight incision, the patients showed a shift toward WTR astigmatism at first postoperative week; then the ATR astigmatism increases progressively up to 3 weeks and stabilizes at 4 to 6 weeks (Graphs 1 and 2).

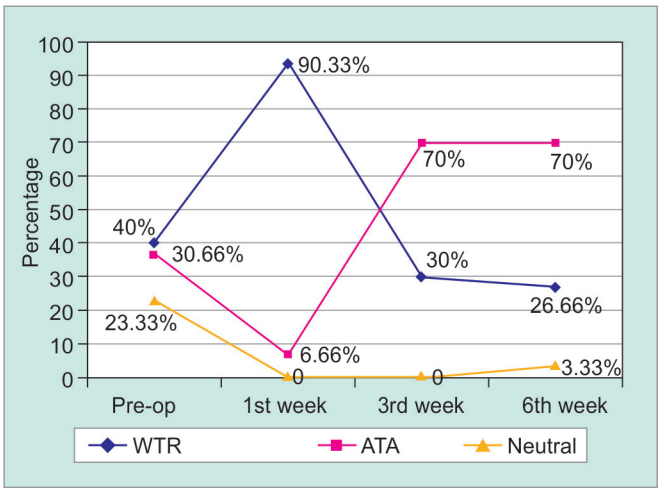
The best corrected visual acuity at 6 weeks of 6/9 or better following frown and straight SICS were 49.9 and 36.6% respectively, 1st week postoperatively; 76.6 and

Table 1: Types of preoperative astigmatism

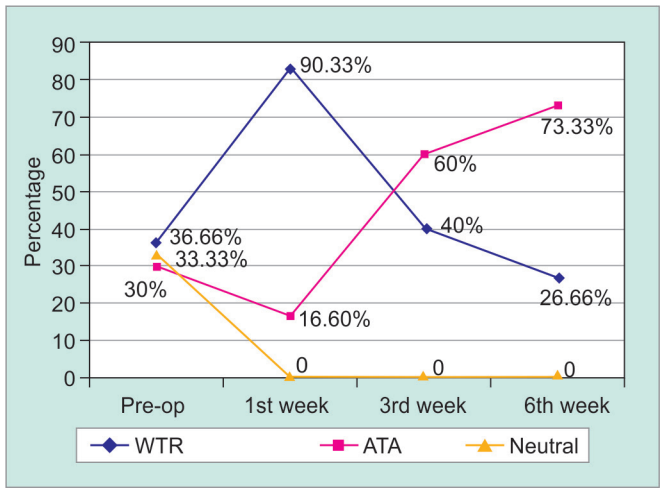
Type of astigmatism	*Frown incision*	*Straight incision*	*Total*
WTR	12 (40%)	11 (36.66%)	23 (38.33%)
ATR	11 (36.66%)	9 (30%)	20 (33.33%)
Neutral	7 (23.33%)	10 (33.33%)	17 (28.33%)
Total	30	30	60

Table 2: Range of astigmatism in diopters preoperatively

Range of diopters	*Frown*	*Straight*	*Total*
Nil–0.25	8 (26.66%)	21 (70%)	29 (48.33%)
0.26–0.5	15 (50%)	6 (20%)	21 (35%)
0.51–0.75	6 (20%)	3 (10%)	9 (15%)
0.76–1.00	1 (3.33%)	–	1 (1.6%)
Total	30	30	60



Graph 1: Course of postoperative astigmatism in relation to preoperative status—frown



Graph 2: Course of postoperative astigmatism in relation to preoperative status—straight

Table 3: Mean astigmatism in diopters

	Frown	*Straight*
Mean net astigmatism	0.45	0.85
Standard deviation	±0.2274	±0.299

53.3% respectively, 3rd week postoperatively; and 83.3 and 76.6% respectively, 6th week postoperatively.

In our study, we found that frown incision had significantly better ($p < 0.001$) mean net astigmatism as compared with the straight incision (Table 3).

It has been noticed that the postoperative ATR astigmatism is common in frown and straight incision, which are both superior incisions (Graph 3).

DISCUSSION

In this study, 60 patients having senile cataract in the age group of 50 to 75 years were studied.

Out of these, the majority were in the age group of 60 to 64 years 28.33%) and only 26.66% were more than 70 years.

Out of the 60 cases, 30 were male patients and 30 were female patients. The male:female ratio is 1:1.

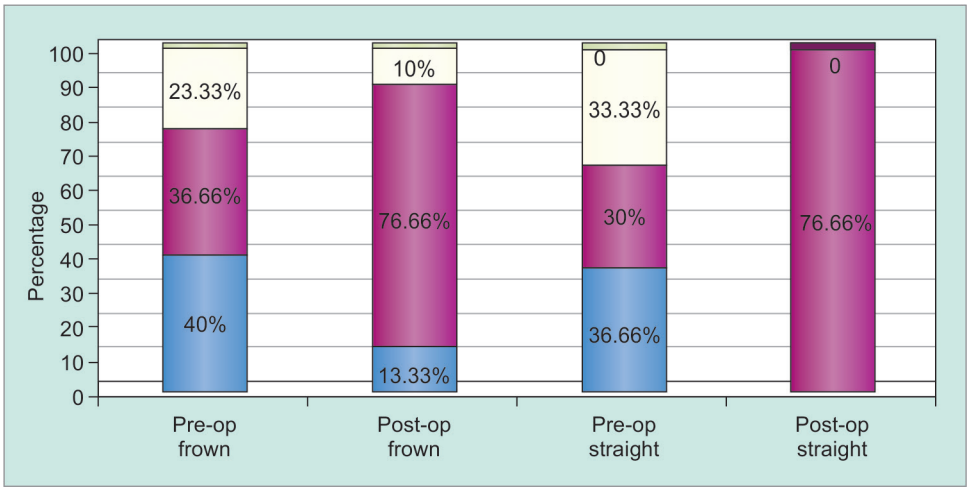
Corneal astigmatism was not present in 28.3% patients, WTR astigmatism was in 38.33% patients. An ATR astigmatism was in 33.33% patients. The WTR was more frequent.

The observation of astigmatism in diopters preoperatively revealed 48.33% patients had astigmatism ≤0.25 D; 35% had astigmatism from 0.26 to 0.50 D, 15% had astigmatism from 0.6 to 0.75 D, and 1.6% had astigmatism from 0.76 to 1.00 D.

To study the course of SIA, keratometry readings taken postoperatively at 1st week, 3rd week, and 6th week were considered.

For analyzing the net astigmatism, keratometry reading taken preoperatively and at 6th week only were considered.

The majority of the patients showed shift toward WTR astigmatism at first postoperative week and then the ATR astigmatism increases progressively up to 3 weeks then



Graph 3: Comparison of type of astigmatism (preoperative and postoperative)

starts stabilizing at 3 weeks. As a result, low-grade astigmatism induced allows useful uncorrected visual acuity very early after surgery, while the stability in refraction achieved early after surgery permits early spectacle.

Gimbel et al[11] concluded that there is a mean flattening of the vertical steep meridian in sutured as well as nonsutured wound.

The majority of the patients showed a shift toward WTR astigmatism at first postoperative week; then the ATR astigmatism increases progressively up to 3 weeks, and stabilizes at 4 to 6 weeks. The initial high WTR astigmatism following SICS is due to following factors:

- Tissue edema, which persists in the immediate postoperative period, may cause wound compression, variation in intraocular pressure, and episcleral cautery.
- The WTR astigmatism following SICS decreases as the tissue edema subsides and as scleral relaxation occurs when the effect of cautery wears off.
- ATR shift occurs due to the mechanism of wound gaps.

Gimbel and Sun[12] compared sutured with unsutured 5 to 6 mm frown incision and considered that in the short term, patients with preoperative WTR astigmatism may benefit from unsutured wound and those with preoperative ATR astigmatism may benefit from sutured wounds if the incision is placed in the vertical meridian.

Pfleger et al[13] compared 3.5 and 4.5 mm sutureless self-sealing scleral tunnel with foldable IOL implantation. The SIA was less than 0.5 D in the early postoperative period and less than 0.25 D at 6 months postoperative in both groups, indicating that a 1 mm difference in size did not affect final astigmatism outcome. Immediately following surgery, there was a decrease in WTR astigmatism as well as a shift toward ATR astigmatism in both groups. The shift remained stable thereafter.

Olsen et al[14] compared induced regular astigmatism and irregular astigmatism after scleral and corneal tunnel incisions on 100 phacomulsification patients with less than 1 D of preoperative astigmatism. The SIA was analyzed by vector analysis from keratometric data. They concluded that the clear corneal incision induces significantly more regular as well as irregular astigmatism than the scleral tunnel incisions.

In our study, we found that frown incision had significantly better ($p < 0.001$) mean net astigmatism as compared with the straight incision. This has also been concluded in a study by Singer.[15] These results suggest that the use of frown incision minimizes induced astigmatism after SICS.

Following studies also prove that the goal of minimizing postoperative SIA after cataract surgery and earlier stabilization can be achieved with frown incision.

A study done by Sinskey and Stoppel[16] concluded that 6.0 mm no stitch frown incision induces low postoperative astigmatism and provides stable incision.

Deng and Liu[17] studied the impact of ECCE and phacoemulsification with 5 mm tunnel incisions or 7 mm frown-shaped incision on the postoperative visual acuity and corneal refractivity in 243 eyes and concluded that 7 mm frown incision of phacoemulsification was the most effective method to control postoperative astigmatism in cataract surgery.

This indicates the stabilization of SIA occurs at 3rd week itself in frown incision SICS than the straight incision in SICS, which was stabilized only at 6 weeks.

The early and better unaided visual acuity following SICS procedure can be attributed to the less induced astigmatism and rapid stabilization of astigmatism following scleral tunnel procedures.

Manual SICS induces significantly lesser astigmatism compared with conventional large incision cataract surgery.

We conclude that small incision size and absence of suture are the most important factors that contribute to less astigmatism and faster stabilization of SICS. The duration for stabilization of postoperative astigmatism in straight incision group is 6 weeks, whereas it is 3 weeks in frown incision. Superior incision group (both frown and straight) had increased amount of WTR astigmatism which later shifted to ATR. There was a significant difference in net astigmatism between frown and straight. Postoperative astigmatism also depends on preoperative astigmatism. Patients with preoperative WTR benefited from superior incision cataract surgery.

The SICS is an effective, fast, and economical technique ensuring satisfactorily less astigmatism and rehabilitation of patients. This still remains an important factor in developing countries like India.

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