Comparing Surgical-Induced Astigmatism through Change of Incision Site in Manual Small Incision Cataract Surgery (SICS)

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Abstract

**Purpose:** To compare the astigmatism induced by a superior versus temporal incision in manual small incision cataract surgery (SICS) in eyes with preoperative “with the rule” corneal astigmatism (WTR).

**Methods:** A prospective comparative study was carried on 35 eyes of 24 patients. All of them had senile cataract and were selected from “Ain Shams university hospitals” ophthalmology outpatient clinic. The patients were subdivided into 2 groups according to site of incision. Group A: 18 eyes (of 13 patients) underwent SICS through superior approach with implantation of PMMA IOL. Group B: 17 eyes (of 11 patients) underwent SICS through temporal approach with implantation of PMMA IOL. The SIA was then calculated for each eye (at day 45 postoperative) and compared.

**Results:** Mean surgical-induced astigmatism (SIA) was found to be significantly lower in the temporal group compared to that in the superior group (P<0.01). The superior incision induced 2.1 D of “against the rule astigmatism (ATR)” while the temporal incision induced 0.7 D of WTR astigmatism.

**Conclusion:** The high SIA induced by superior incision may prove useful when aimed at reducing high levels of preoperative corneal WTR astigmatism (around 2 D). On the other hand, temporal incision is recommended in patients with low levels of preoperative WTR astigmatism. The exact cut-off value is to be studied.

Introduction

Cataract surgery has become one of the most common and successful procedures in ophthalmology. In addition to improving visual acuity (VA), one of the goals of modern cataract surgery is to reduce pre-existing astigmatism (PEA), a factor that may reduce VA and affect the quality of vision [1].

Various strategies currently available to the cataract surgeon can safely and effectively reduce corneal astigmatism during lens-based surgery. These techniques require careful preoperative surgical planning particularly as regards incision design and site. Employing advanced enhancement techniques (such as corneal relaxing incisions) and/or toric intraocular lens (IOL) technology may also help surgeons to achieve postoperative emmetropia [2].

As regards the choice of incision location, previous studies reported that superior incision induces greater corneal astigmatic change (against-the-rule astigmatism) (ATR), than temporal incision (which induces with-the-rule astigmatism) (WTR) [3-5]. In addition, with-the-rule astigmatism is preferred as it frequently allows better uncorrected visual acuity [6]. Others recommend choosing the location of corneal incision based on preexisting astigmatism by placing the incision on the steeper corneal meridian (on-axis incision) to reduce significant preoperative astigmatism [7].

While phacoemulsification remains the more advanced and technically superior method of cataract surgery, it is not always appropriate either from a cost perspective or the density of the cataracts involved [8]. Small incision manual extracapsular techniques (SICS) - the first choice alternative to phacoemulsification- retains most of the advantages of “phaco” giving visual results equivalent to phacoemulsification at lower cost. However, the larger incision used induces greater astigmatism than phacoemulsification [9].

In view of the previous findings, the study aimed to compare between the surgically induced astigmatism (SIA) in manual SICS by superior (on-axis) incision and temporal incision; to determine the possibility of reduction of preoperative “with the rule astigmatism” (WTR) in patients undergoing SICS.

Patients and Methods

This prospective comparative study included 35 eyes of 24 patients. All of them had senile cataract and were selected from “Ain Shams University Hospitals” ophthalmology outpatient clinic.

The patients were randomly subdivided into 2 groups according to site of incision (Table 1):

Group A: 18 eyes (of 13 patients) underwent SICS through superior approach with implantation of PMMA IOL (Figure 1a).

Group B: 17 eyes (of 11 patients) underwent SICS through temporal approach with implantation of PMMA IOL (Figure 1b).

![Figure 1: a; SICS (superior approach); b; SICS (temporal approach).](image-url)
The inclusion criteria were:
- Significant senile cataract.
- Keratometric WTR astigmatism.

The exclusion criteria were:
- Complicated cataract, and pseudo exfoliation.
- Pre-existing pathology other than cataract causing diminution of vision such as corneal opacities, macular disorders and optic nerve diseases.
- Any patient who had undergone previous ocular surgery (trabeculectomy, refractive or retinal detachment surgery).

Preoperatively, a full ophthalmic examination was done including:
- Uncorrected visual acuity (UCVA),
- Best-corrected visual acuity (BCVA),
- Keratometry and ‘A-scan’ biometry.

Keratometry was performed using Javal Shiotz keratometer (to determine preoperative corneal astigmatism). All patients also signed an informed consent.

The patients were scheduled for Manual SICS at the department of Ophthalmology Ain-Shams University Hospitals. All surgeries were done under peribulbar anesthesia. The incision architecture was similar in the 2 groups. A 6 mm scleral straight incision, 1.5 mm from the limbus was made with a number 15 Bard Parker blade. A funnel shaped sclerocorneal pocket incision was created with a crescent knife. One side-port was made 90 degrees apart of the scleral tunnel with a 15 degree angulation knife. With a 3.2 keratome, the anterior chamber was entered 1.5 mm into the clear cornea and the internal incision was enlarged sideways to 8 mm. A single piece PMMA IOL of 6mm optic size and 12.5 mm total size was implanted into the capsular bag. No sutures were given.

Postoperatively, topical prednisolone acetate 1% eye drops were administered six times a day in the first week and gradually tapered every week over six weeks. Topical ofloxacin eye drops 0.3% were administered four times a day for the first ten days and then discontinued.

Patients were thoroughly examined postoperatively on days 1, 7, 15 and 45 after surgery. The preoperative and postoperative keratometric readings (at day 45 of follow-up visit), for each eye were used for statistical analysis. Amplitude of astigmatism was calculated from the difference in the keratometric value in the steeper and flatter meridian, using the plus cylinder notation.

The SIA was then calculated for each eye using vector analysis method [10]: astigmatism vectors are drawn using a protractor and a ruler;

A horizontal baseline is drawn, on which a center point is marked. First, the preoperative vector (K1) is depicted, by drawing a line from the center outward, at an angle double the preoperative astigmatism angle, and equal in length to the magnitude of the preoperative astigmatism. For the magnitude, a convenient scale can be chosen (in the present study, the scale used was one dioptre = one centimeter).

Next, the postoperative vector (K3) is drawn, again beginning at the center and going outwards. These two lines are joined. This third line is the resultant vector and represents SIA (K2). The junction of this line and the postoperative vector is marked as the ‘head’, and its other end as tail. To determine the exact SIA, this line is measured and the reading is converted into dioptic value using the earlier scale. This is the magnitude of SIA.

A horizontal line is drawn through the tail of the resultant vector, and the angle that the resultant makes with it is measured. Halve this angle, and it gives the axis of SIA (Figure 2) [10].

Statistical analysis was performed using Statistical Package for Social Sciences software-Windows Version-17 (SPSS-17).

Results

This study included 35 eyes of 24 patients. There were no significant differences in the age, sex, or preoperative astigmatism between the two groups (Table 1).

Applying vector analysis method, the SIA was calculated, (scale used was, one dioptre = one centimeter).

In group A (superior incision), the mean preoperative astigmatism was 1.63 D @ 93; the mean postoperative astigmatism was -0.42 D @ 11. The mean SIA was calculated as -2.1 D @ 5 (Figure 3a).
In conclusion, the high SIA induced by superior incision may prove useful when aimed at reducing high levels of preoperative corneal WTR astigmatism (around 2 D). On the other hand, temporal incision is recommended in patients with low levels of preoperative WTR astigmatism. The exact cut-off value is to be studied.

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Table 1: Preoperative data of the patients.

| Sex       | No. of eyes | Age in years (range) (mean ±SD) | No. of patients |
|-----------|-------------|---------------------------------|-----------------|
| Male      | 5           | 68-79 (66.2± 6.7)               | 13              |
| Female    | 6           | 56-83 (65.5± 4.6)               | 11              |

Table 2: Pre, post, and surgically induced astigmatism in both groups.

| Group     | Mean preoperative astigmatism (D) | Mean postoperative astigmatism (D) | Mean SIA astigmatism (D) | P value |
|-----------|-----------------------------------|-----------------------------------|--------------------------|---------|
| Group A   | 1.63±1.23                         | -0.42±1.17                        | -2.05±1.19               | <0.01*  |
| Group B   | 1.38±1.03                         | 1.84±1.36                        | 0.46±0.43                | <0.01*  |

*Statistically significant (P<0.01)

Discussion
The term “refractive cataract surgery” has come to represent a reality for our cataract patients. In order to achieve excellent visual results, the effect of astigmatism on postoperative vision must be minimized [1].

Today’s cataract incisions provide better control of surgically induced astigmatism, either by using temporal approach to produce “agnostically neutral” surgery or by using on-axis incision to induce astigmatism at the steep axis to counteract preexisting astigmatism [11].

In the present study, the astigmatism induced by a superior (on-axis) incision versus temporal incision in manual SICS in eyes with preoperative “with the rule” corneal astigmatism was compared. It was measured using vector analysis method, which is a simple, powerful, and accurate method. However, it is tedious requiring patience [10].

The SIA was found to be significantly lower in the temporal group compared to that in the superior group. This is in agreement with previous studies [3-5].

The superior incision induced 2.1 D of “against the rule astigmatism”. This was greater than SIA by superior incision in phacoemulsification (1.5 D) as reported by Tejedor and Murube [12], which is explained by the larger incision size in SICS. Also it was higher than that mentioned by Haldipurkar et al. [13] who reported 1.2 D in SICS. The high SIA in this study may help to neutralise a pre-existing WTR astigmatism of 2 D, and to reduce significant WTR astigmatism of > 2 D using superior incision.

On the other hand, temporal incision induced an average SIA of 0.7 D of WTR astigmatism which is a low value. Hence, it doesn’t jeopardize low levels of WTR astigmatism.