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Amount of Surgically Induced Astigmatism: Manual Small Incision Cataract Surgery

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ABSTRACT
Manual small incision cataract surgery is one of the most innovative and popular technique. The use of small cataract incision is thought to reduce surgically induced astigmatism resulting in more stable refraction. There are many factors responsible for surgically induced astigmatism such as the location and type of cataract incision, size, configuration of wound, suture material used, technique of wound closure etc. We conducted a prospective study on 100 patients who underwent suture less small incision cataract surgery. They were randomised into 3 groups. The group assignment was determined after surgery, based on chord length of external incision used into 6.0mm (Group A), 6.5mm (Group B) and 7.0 (Group C). The mean surgically induced astigmatism after 6 weeks of surgery was 0.47D in Group A, 0.61D in Group B and 0.69D in Group C. This showed that a 6.0mm incision induced a relatively lower surgically induced astigmatism as compared to 6.5mm and 7.0 mm incisions.

INTRODUCTION

Astigmatism, the so-called final frontier of cataract surgery, is an area of research where few venture. As cataract surgeons set their sights on post-operative emmetropia, an understanding of astigmatism becomes necessary. Corneal astigmatism has been a byproduct of cataract surgery since the first limbal incision was put. Cataract surgery incisions have been known for >a century to influence astigmatism. Significant astigmatism may be visually disabling causing diminution in visual acuity, glare, monocular diplopia, asthenopia and distortion. A number of procedures have been developed to minimize and stabilize surgically induced astigmatism. Manual small incision cataract surgery is one of the most innovative and popular technique. The use of small cataract incision is thought to reduce surgically induced astigmatism resulting in more stable refraction. There are many factors responsible for surgically induced astigmatism such as the location and type of cataract incision, size, configuration of wound, suture material used, technique of wound closure etc[1]. Total post-operative refractive astigmatism and keratometric corneal astigmatism were determined in patients following cataract surgery. By comparing the results of the two methods, the value of keratometry as a simple and quick procedure for identification of surgically induced astigmatic errors was established[2]. Calculating the surgically induced refractive changes following surgery is important for evaluating the results of smaller incision and various wound closures for cataract surgery. The classic formula for calculating surgically induced refractive change was described over 100 years ago. It is assumed that the induced corneal spherical and astigmatic change could be represented by a sphere and cylinder which when placed in front of the eye, at the corneal vertex produced the same optical effect as the surgery. Jaffe and Clayman[3] used vector analysis and described three trigonometric methods for performing these calculations. The fundamental advantage of this approach is inherent consistency between refractive and keratometric changes and its sound mathematical basis. Olsen[4] modified the work of Holladay[5] and devised a simpler method, originally described by W.E. Humphery which is based on astigmatic decomposition of any cylinder into two vector components at 0 and 45 respectively. Carvy 3 adopted a different approach and developed a formula based on keratometric values. It permits calculation of aggregate with the rule or against the rule changes. Kristian Naeser[6] devised a method to describe corneal astigmatism. The net astigmatism was divided into two components and polar values calculated using law of sines and cosines. An easy way is subtraction method. The difference in keratometric readings pre and post operatively gives an idea of the astigmatic change although the axis is not taken into account. This method of calculating astigmatism is used in the present study.

MATERIALS AND METHODS

We conducted a prospective study on 100 patients who underwent suture less small incision cataract surgery. They were randomised into 3 groups. The group assignment was determined after surgery, based on chord length of external incision used into 6.0mm (Group A), 6.5 mm (Group B) and 7.0 (Group C).

Inclusion Criteria:

- Patients undergoing manual small incision cataract surgery.
- Patients within age group of 30-90 years.
- Patients with presenile/senile cataract.

Exclusion Criteria:

- Patients below 30 years of age.
- Patients above 90 years of age.
- Patients with ocular trauma, infection, inflammations, pterygium, congenital anomalies of eye.
- Patients with history of previous ocular surgeries (trabeculectomy, retinal detachment, surgery).
- Patients with any retinal pathologies, glaucoma, disease of posterior segment of eye.

Study Period: September 2023-September 2024.

Pre-operative Keratometric cylinder was recorded using a standard calibrated Bausch and Lomb Keratometer. The visual acuity, type of cataract and fundus, wherever possible were noted and recorded in the proforma. All patients were dilated with Tropicamide 0.8% and phenylephrine 5% eye drops, unless contraindicated. Surgery was performed under peribulbar anesthesia. A 3-step incision was made starting 1.5-2.0mm behind the limbus. First a partial thickness incision was made perpendicular to the sclera. The groove was then dissected forwards lamellarly along the contour of the globe, about 1.0 mm into the cornea using a cresent knife. The anterior chamber was entered using a keratome by “dimple-down” manoeuvre. The length of the incision was decided on table depending on the size and hardness of the nucleus.

RESULTS AND DISCUSSIONS

Table 1: Amount of Surgically Induced Astigmatism in the 3 Groups (Subtraction Method)

SIA(D)	Group A		Group B		Group C	
	(No.)	%	(No.)	%	(No.)	%
0.0	3	6.9	4	10.3	1	1.4
0.1-0.5	19	61.3	16	47.2	18	52.2
0.6-1.0	8	23.8	9	27.5	10	29.4
1.1-1.5	2	4.9	3	8.7	3	8.5
1.6	1	3.1	2	6.2	2	8.2

(Table 1) shows the amount of surgically induced astigmatism seen in the 3 groups after 6 weeks. This

has been calculated using subtraction method. Maximum number of patients showed a <1.0 D of induced astigmatism. Most of these patients fell in the range of 0.1-0.5D. It was seen in 61.3% of the patients in Group A, 47.2% in Group B and 52.2% in Group C.

Table 2: Mean Surgically Induced Astigmatism After 6 weeks

	Group A	Group B	Group C
SIA (D)	0.47	0.61	0.69

The mean surgically induced astigmatism after 6 weeks of surgery was 0.47D in Group A, 0.61D in Group B and 0.69D in Group C. This showed that a 6.0 mm incision induced a relatively lower surgically induced astigmatism as compared to 6.5 mm and 7.0 mm incisions.

Table 3: Mean Astigmatism (D) in the 3 Groups Over the Period of Study

	Group A	Group B	Group C
Pre-operative	0.61	0.59	0.77
Day 1	0.80	1.03	0.97
1 week	0.79	1.07	0.98
6 weeks	0.76	0.97	0.91

A mean immediate post-operative astigmatism of 0.80D was seen in Group A which decreased to 0.76D by 6 weeks. In Group B, 1.03D of mean astigmatism was seen immediate post- operatively which decreased to 0.97D by 6 weeks. Group C patients had mean astigmatism of 0.97D immediate post- operatively which decreased to 0.91D by the end of 6 weeks. The amount of mean astigmatism seen immediate post-operatively reduced progressively over the 6 week period.

Table 4: Amount of Astigmatism and Astigmatic Change Over 6 Week Period

Astigmatism(D)	Pre-op		Day 1		1 week		6 weeks	
	WTR	ATR	WTR	ATR	WTR	ATR	WTR	ATR
0	19		8		2		8	
0.1-0.5	17	15	4	15	3	14	4	17
0.6-1.0	6	17	11	16	6	17	7	17
1.1-1.5	1	11	5	11	9	13	2	16
1.6-2.0	6	5	6	9	5	9	3	9
2.1-2.5	0	3	3	5	4	8	3	6
2.6-3.0	0	0	4	3	3	7	1	7
Total (No.)	30	51	33	59	30	68	20	72
%	30	51	33	59	30	68	20	72

Table 5: Proportion of Patients Showing <1.0 D and >2.5 D Astigmatism

Astigmatism (D)	Pre-op		Day 1		1 week		6 weeks	
	WTR	ATR	WTR	ATR	WTR	ATR	WTR	ATR
0.1-0.5	17	15	4	15	3	14	4	17
(Percentage)	53.1	46.9	21.1	78.9	17.6	82.4	19	80.9
0.6-1.0	6	17	11	16	6	17	7	17
(Percentage)	26.1	73.9	40.7	59.3	26.1	73.9	29.2	70.8
>2.5	0	0	4	3	3	7	1	7
(Percentage)	0	0	57.1	42.9	30	70	12.5	87.5

The proportion of patients showing ≤1.0 D of astigmatism is shown in Table-12. A shift towards against the rule astigmatism is seen post-operatively which continues to remain even at the end of 6 weeks. Against the rule astigmatism was seen in 51% of patients preoperatively and 72% at the end of 6 weeks. The amount of astigmatism induced did not have any bearing on the type of astigmatism being induced. Of the patients with astigmatism between 0.1-0.5 D, against the rule was seen in 80.9% of patients and in those with >2.5 D, it was seen in 87.5% of patients at the end of 6 weeks. The stabilization of cylinder was seen by the end of the first post-operative week in some and in most by the 6 weeks. This was true for those with smaller induced cylinders as can be seen in Table-11. In the group showing 0.1-0.5 D astigmatism, against the rule was seen in 82.4% after 1 week, and 80.9% after 6 weeks. A similar trend was seen in patients showing 0.6-1.0 D of astigmatism with 73.9% showing against the rule at day 7 and 70.8% after 6 weeks. In patients with >2.5 D of astigmatism, a stable cylinder was achieved late with 42.9% showing against the rule on the first post- operative day, 70.0% on day 7, and 87.5% after 6 weeks. After applying the Chi-square test, a statistically significant decrease in with the rule astigmatism was seen in patients over the 6 weeks of study ($p<0.0001$). An increase in against the rule astigmatism was seen but this was not statistically significant ($p=0.06$). Overall a significant decrease in with the rule astigmatism was seen in patients showing <1.0 D of cylinder ($p<0.0001$) and an increase in against the rule astigmatism was seen ($p=0.04$).

Cataract surgery and surgeons have long realized that the surgical wound induces a significant change in the astigmatic properties of the eye post operatively. In efforts to avoid or minimize these changes, there has been a progressive shift towards smaller incision sizes. However, that incision size which renders the eye astigmatically neutral, is yet to be established. A prospective analysis of post operative astigmatism based on keratometric measurement of 137 cases of conventional extra capsular cataract extraction showed 1.44 D of with the rule astigmatism at 1 month which declined at the rate of 0.77 D and 0.35D per month for the next two months respectively, with more gradual decline there after. Their findings suggest that corneal curvature continues to change slowly even 2-4 years post operatively and most patients eventually develop against the rule astigmatism. Induced astigmatism and post operative wound stability was evaluated by 4 surgeons in a study of 130 patients. Vector analysis calculations of mean post operative induced astigmatism for small incision versus conventional incision groups were: At day 1,1.54 D versus 3.07 D, at 1 and 2 weeks, 1.0 D versus 2.34 D., at one month, 0.98 D versus 1.44 D. All these values were statistically significant. Analysis of the suturing technique for the 6.5mm incision showed that the technique of wound closure and wound size influenced induced astigmatism. Grabow 7, in comparing the results of 500 no-stich cases with varying incision lengths, concluded that surgically induced astigmatism at 3 months post

operative averaged 0.46 D for 4.0mm group, 0.57D for 5.2 mm and 0.52D for the 7.0mm incision groups. At 3 months postoperative, the uncorrected visual acuity of 20/40 was observed in 83%, 72% and 75% in 4.0, 5.2 and 7.0 mm incision cases, respectively. In another prospective trial comparing the effect of smaller incision versus larger incision in reducing surgically induced astigmatism, it was found that 1 day after surgery, the larger incision group had significantly higher mean astigmatism (2.28 D) than the smaller incision group (1.28 D). However, the two groups were comparable by 3 months. Induced astigmatism of >1.0D was observed in the clinics of Pham and Wollensack8, in no stitch technique used on 1500 patients. In a study on 138 eyes operated with 6.5 mm and 12.0mm chord length incisions, the induced cylindrical change was 1.20±0.60 D and 2.2±1.3 D, respectively. All cases showed a significant against the rule shift, which was independent of the amount of surgically induced, with the rule, astigmatism at the time of surgery. Early astigmatic changes and rehabilitation in 20 eyes operated with 4.0 and 7.5 mm incisions were compared. Less initial induced astigmatism was seen 1 week post-operative with 4.0 mm than with 7.5 mm incision. Similar but statistically non- significant changes were seen 1 and 30 days post operatively. Visual rehabilitation was also faster, with 70% eyes showing uncorrected visual acuity of >20/40 as early as 1stpost operative day in the small incision groups as compared to 11% in the larger incision groups[7-9]. Post operative astigmatism course of un sutured and sutured small incisions followed for 1year revealed a small against the rule change that did not differ clinically or statistically in both the groups. Surgically induced astigmatism was evaluated in 116 eyes, which underwent extra capsular cataract extraction with intraocular lens implantation through 4.0, 6.0, or 11.0 mm incisions. 1 week and 1 month post operatively, 4 mm incision groups had significantly lower mean induced cylinder and higher proportion of cylinder $\leq$1.5 D. However, 3 months post operatively, no significant difference in any parameter was noted. This study done in 3 groups of 50 eyes showed no statistically significant differences between 7.0-7.5 mm and 10-11mm incisions which showed a surgically induced astigmatism of 1.78±0.90 D and 1.82+0.95 D respectively. A statistically lower astigmatism was seen with smaller incisions[7-9].

CONCLUSION

The induced astigmatism immediately post-operative and at any follow up was against the rule in maximum number of patients. Thus, suture less incisions induced a flattening of the surgical meridian but this did not significantly differ between incision lengths of 6.0-7.0mm.

REFERENCES

1. Gills, J.P. and D.R. Sanders, 1991. Use of small incisions to control induced astigmatism and inflammation following cataract surgery. J. Cataract Refractive Surg., 17: 740-744.
2. Koch, P.S., 1991. Structural analysis of cataract incision construction. J. Cataract Refractive Surg., 17: 661-667.
3. Holladay, J.T., T.V. Cravy and D.D. Koch, 1992. Calculating the surgically induced refractive change following ocular surgery. J. Cataract Refractive Surg., 18: 429-4420.
4. Olsen, T., 1993. Simple Method to Calculate the Surgically Induced Refractive Change. J. Cataract Refractive Surg., 19: 319-320.
5. Naeser, K., 1990. Conversion of keratometer readings to polar values. J. Cataract Refractive Surg., 16: 741-745.
6. Grabow, H.B., 1991. Early results of 500 cases of no-stitch cataract surgery. J. Cataract Refractive Surg., 17: 726-730.
7. Pham, D. and J. Wollensak, 1992. „No-Stitch"-Kataraktchirurgie als Routineverfahren -Technik und Erfahrung. Klinische Monatsblätter für Augenheilkunde, 200: 639-643.
8. Heinrich, T., H. Höh, S. Schalm, R. Kowoll and K. Ruprecht, 1994. Der Astigmatismus gegen die Regel nach Kleinschnitt-Kataraktchirurgie - Eine multifaktorielle, multivariate Studie. Klinische Monatsblätter für Augenheilkunde, 204: 262-264.
9. Hunold, W., G.U. Auffarth, S. Bälitsis, E. Mehdorn and T. Wesendahl., 1995. No-stitch tunnel incision vs corneoscleral incision: A prospective, randomized study. Ophthalmology., 102: 274-279.