Journal of Cardiovascular Disease Research

ISSN: 0975-3583, 0976-2833 VOL 14, ISSUE 06, 2023

A COMPARATIVE STUDY ON SURGICALLY INDUCED ASTIGMATISM AFTER PHACOEMULSIFICATION AND ITS RELATION WITH CORNEAL WHITE TO WHITE DIAMETER

Chiman Lal[1], Mohit Goyal[2], Vishu Bansal[3], Divjot Kaur[4], Talvir Sidhu[5]*

1.Assistant Professor, Department of Ophthalmology, Government Medical College, Patiala, Punjab -147001, India.
2.Senior Resident, Department of Ophthalmology, Government Medical College, Patiala, Punjab -147001, India.
3.Junior resident, Department of Ophthalmology, Government Medical College, Patiala, Punjab -147001, India.
4.Assistant Professor, Department of Ophthalmology, Government Medical College, Amritsar, Punjab -143001, India.
5.Assistant Professor, Department of Ophthalmology, Government Medical College, Patiala, Punjab -147001, India.

***Corresponding author**
Dr Talvir Sidhu, Assistant Professor, Department of Ophthalmology, Government Medical College, Patiala, Punjab -147001, India.
Email: talviraiims@gmail.com
ORCID id: https://orcid.org/0000-0003-4281-3213

ABSTRACT

Aims: To evaluate the surgically induced astigmatism after phacoemulsification and its relation with white-to-white diameter.

Methods: This was a prospective study that included 115 senile cataract eyes (59 males and 56 females) that underwent phacoemulsification with foldable acrylic IOL implantation at Ophthalmology department of Government Medical College Patiala, from January 2022 to May 2022. A detailed preoperative workup was done including biometry and white-to white diameter and phacoemulsification was performed using a 2.8 mm clear corneal incision. Three groups were divided according to corneal white to white diameter – Group A: <11.60mm, Group B: 11.60-12.20mm and Group C: >12.20 mm. Surgically induced astigmatism was calculated and compared according to the white-to-white diameter. Keratometry and visual acuity examinations were done postoperatively after 4 weeks, 8 weeks and 12 weeks.

Results: The mean age of all participants was 59.11±10.8 (males vs. females; p=0.15). The mean preoperative astigmatism in all participants was 0.78±0.36 (Gp A vs Gp B vs Gp C; p=0.66) and at 12 weeks 0.96 ± 0.68 (Gp A vs Gp B vs Gp C; p=0.82). Surgically induced astigmatism at 12 weeks was: Group A 0.85 ± 0.33; Group B 0.69 ± 0.29; and Group C 0.57 ± 0.20 (p=0.04). **Conclusion:** Large corneal white-to-white diameter is associated with statistically lower mean surgically induced astigmatism as compared to smaller white to white corneal diameter, although there is no difference in post-operative uncorrected visual acuity.

Keywords: Phacoemulsification, white-to-white, astigmatism

ISSN: 0975-3583, 0976-2833 VOL 14, ISSUE 06, 2023

1. INTRODUCTION

Cataract surgery has evolved from visual rehabilitation to a more precise refractive surgery (1). Surgically induced astigmatism (SIA) plays an important role in achieving desired Uncorrected Visual Acuity (UCVA). The incisions for cataract surgery have also evolved from earlier corneoscleral to now smaller clear corneal incisions which are easy to make and prevent conjunctival scarring and have lower chances of causing conjunctival hemorrhage and hyphema (1, 2). The role of corneal incision size and placement has been studied thoroughly in literature for its effect on postoperative astigmatism (3). Temporal incisions were found to induce similar or less astigmatism as compared to the incisions at other locations. (1),(4), (5).

However, surgically induced astigmatism is not only affected by incision placement or incision size and axis but also ocular parameters such as corneal pachymetry(6) and pre-operative astigmatism(7) and even corneal diameter(8). In this prospective study, we evaluate the surgically induced astigmatism after phacoemulsification and its relation with white-to-white diameter.

2. METHODS

This prospective study was done at Ophthalmology department of Government Medical College Patiala, from January 2022 to May 2022. 115 eyes of 115 senile cataract patients undergoing phacoemulsification with foldable acrylic IOL implantation through an unsutured 2.8 mm clear corneal incision were included. Patients above 40 years of age with senile cataract undergoing phacoemulsification with foldable acrylic IOL implantation through an unsutured 2.8 mm clear corneal incision were included in the study. Patients with age below 40 years, preoperative inflammatory ocular condition, ocular diseases like glaucoma and diabetic retinopathy, corneal surface irregularity or unreliable keratometric readings, and a history of previous ocular surgery or disease affecting corneal refraction were excluded. Patients with systemic connective tissue disease and those taking systemic steroids or immunosuppressive drugs were also excluded. All patients underwent preoperative visual acuity, intraocular pressure measurement using Goldmann applanation tonometry and fundoscopy. Axial length was performed using A-scan ultrasound and keratometry using auto-keratometer (Nidek- ARK-1), white-to-white with pentacam (Oculus Inc). The participants were divided into three groups- Group A- White to White <11.60mm; Group B- White to White 11.60mm-12.20mm; Group C - White to White >12.20mm.

All patients underwent phacoemulsification with foldable acrylic IOL implantation through an unsutured 2.8 mm clear corneal incision. All surgeries were performed by the single surgeon (TS) using topical proparacaine 0.5% eyedrops as anesthesia. Two clear corneal side port incisions were made using 19-gauge MVR knife 2-3 clock hours on either side of the main port incision. The incisions in right eye were placed at 120^{o} degrees at the cornea and at 30^{o} degrees in the left eye to maintain symmetry. Approximately five mm diameter sized central continuous curvilinear capsulorrhexis was performed using a utrata capsulorrhexis foreceps. Hydrodissection was performed from the main port incision. The nucleus was emulsified using Oertli Faros phacoemulsifier machine (Oertli Instrumente AG, Hafnerwisenstrasse, Berneck, Switzerland) and the cortex was removed using bimanual irrigation aspiration probe. Single piece foldable hydrophobic acrylic IOL was implanted in the capsular bag with a syringe and cartridge system followed by bimanual irrigation and aspiration to remove the residual viscoelastic material. All the incisions were left unsutured, and stromal hydration of the wound edges was performed. Patients were given combination of prednisolone acetate 1% and gatifloxacin 0.3% three hourly, and the regimen was tapered

over the first postoperative month. Complete ophthalmological examination was done preoperatively and postoperatively after 4 weeks, 8 weeks and 12 weeks, including keratometry and visual acuity. Astigmatism was measured by keratometry readings. Data on gender, age, UCVA, BCVA, keratometry and white-to-white corneal diameter were collected. The primary outcome of the study was post-operative surgically induced astigmatism and visual acuity.

Institutional ethics committee review board clearance was taken– (Trg.) EC/NEW/.INST/2020/997/9420. Study protocol adhered to the tenets of declaration of Helsinki. A written informed consent was taken from all the participants after explaining the study details.

Calculation of Surgical Induced Astigmatism (9)

The pre-operative keratometry values, K1 for the vertical meridian and K2 for the horizontal meridian were measured. The difference between the two was the pre-operative astigmatism. Similarly, Post-operative K1 and K2 values were measured and the difference calculated. Surgically induced astigmatism is calculated by the subtraction of pre-operative astigmatism from the postoperative value without assigning any sign for the absolute value. Visual acuity was converted to decimals for comparison. The data was collected and noted in excel format. Data was subjected to statistical analysis using STATA software version 12.1 (Stata Corp. LP, College Station TX). A p-value less than 0.05 was considered statistically significant.

3. RESULTS

The study included 115 eyes of 115 participants with Group A (White to White <11.60mm)- 31 eyes, Group B (White to White 11.60-12.20mm)- 59 eyes and Group C (White to White >12.20mm)- 25 eyes. There were 59 male participants and 56 female participants. The mean age of all participants was 59.11±10.8 years, male participants was 60.5±10.6 and female participants was 57±10.63 years (p=0.15). The average white to white diameter was 11.83±0.44mm (males: females; p=0.12). Table 1 shows the age and gender wise distribution of participants in the three groups. The three groups were statistically similar in terms of age and gender distribution.

Table 1: Baseline data of participants

Eyes	Group A	Group B	Group C	p-value
Total number	31	59	25	0.33
No. of Male	13	30	16	
No. of Female	18	29	09	
Age (years)	57.33 ± 9.38	59.2 ± 10.34	61.06 ± 13.3	0.37
White-to-white (mm)	11.27 ± 0.24	11.88 ± 0.18	12.39 ± 0.18	**0.001**

The mean preoperative astigmatism in all participants was 0.78±0.36 diopters, in males was 0.73 ±0.43 diopters and in females was 0.81±0.34 diopters (p=0.26). Table 2 shows the change in mean total astigmatism before the phacoemulsification surgery and after the surgery at every follow up. There was no statistically significant difference between the three groups before the surgery and after the surgery.

Table 2 shows the change in surgically induced astigmatism change by vector analysis using the Holladay–Cravy–Koch formula after the surgery at every follow up. After the surgery, the surgically induced astigmatism was found to be lowest in Group C, followed by Group B and highest in Group A at every follow up visit at 4 weeks, 8 weeks, and 12 weeks. At 12 weeks

ISSN: 0975-3583, 0976-2833 VOL 14, ISSUE 06, 2023

follow up, the difference in surgically induced astigmatism between the three groups was found to be statistically significant.

The mean Uncorrected Visual Acuity (UCVA) before the surgery was 0.21± 0.09 decimals and after the surgery at 12 weeks follow up was 0.93 ± 0.20 ($p<0.001$). The UCVA improved significantly post operatively in all groups; without any significant difference between the three groups in terms of UCVA. (Table-2)

Table 2: Mean total Preoperative and Postoperative astigmatism, surgically induced astigmatism and uncorrected visual acuity.

	Mean total astigmatism (diopters) ± SD			**p-value**
	Group A	**Group B**	**Group C**	
Preoperative astigmatism (diopters)	0.83 ± 0.32	0.76 ± 0.39	0.79 ± 0.36	0.66
Postoperative astigmatism (diopters)				
4 weeks postop	1.36 ± 0.82	1.22 ± 0.79	1.14 ± 0.91	0.59
8 weeks postop	1.14 ± 0.73	1.05 ± 0.72	0.96 ± 0.72	0.42
12 weeks postop	1.06 ± 0.74	0.92 ± 0.67	0.91 ± 0.63	0.82
Surgically induced astigmatism (diopters)				
4 weeks postop	1.05 ± 0.48	0.82 ± 0.43	0.68 ± 0.25	**0.01**
8 weeks postop	0.91 ± 0.42	0.72 ± 0.33	0.63 ± 0.24	**0.05**
12 weeks postop	0.85 ± 0.33	0.69 ± 0.29	0.57 ± 0.20	**0.04**
Mean UCVA ± SD (decimal)				
Preoperative	0.21 ± 0.08	0.22±0.09	0.23 ± 0.10	0.25
Postoperative 12 weeks	0.91 ± 0.21	0.93 ± 0.21	0.94 ± 0.18	0.58

4. DISCUSSION

Surgically induced astigmatism after phacoemulsification surgery depends on various factors. Site and location of incision is an important factor (3, 10) and various studies comparing the surgically induced astigmatism with temporal incision was found to be least.(3, 5, 11). Other ocular factors contributing to Surgically induced astigmatism like white-to-white diameter have been explored less.(8)

In the present study, we performed phacoemulsification with standardized 2.8 mm sutureless incisions and foldable acrylic IOL implantation in 115 eyes with senile cataract. The patients were followed up by visits at 4 weeks, 8 weeks, and 12 weeks. We found that in terms of mean total astigmatism, there was no statistically significant difference between the three groups before the surgery and after the surgery, at every follow up visit at 4 weeks, 8 weeks and 12 weeks. However, the surgically induced astigmatism changes by vector analysis using the Holladay–Cravy–Koch formula after the surgery at every follow up was found to be significantly lowest eyes with high corneal diameter and vice versa. This could be a result of incision placement nearer to center of cornea in eyes with smaller corneal diameter. A study by Theodoulidou et al found that eyes with smaller corneal white to white diameter had high surgically induced astigmatism and higher change in overall astigmatism at six months postop. They also found that there was no significant shift in axis of astigmatism with respect to white to white diameter change.(8)

In our study, we found that the average white-to-white corneal diameter was 11.83±0.44mm. Singh et all also reported an average corneal diameter of 11.79 ± 0.67 mm with IOL master in

ISSN: 0975-3583, 0976-2833 VOL 14, ISSUE 06, 2023

Indian population.(12) Our study did not show a significant difference between corneal diameter in males versus females, however, Singh et al showed that females had significantly lower average white-to-white corneal diameter as compared from males.(12) In a study by Wei et al, in Chinese population undergoing cataract surgery, the average white to white was found to be 11.81 ± 0.44mm in males and 11.57 ± 0.43mm in females.(13) It has been shown that Pentacam and IOL master can be used interchangeably for measuring white to white diameter.(14) In Tehran eye study, the white to white diameter showed a strong correlation with corneal radius of curvature (r = 0.422) and axial length (r = 0.384).(15) The white to white diameter was found to be similar in males and females, had no correlation with age, and showed 0.18mm increase with each millimeter increase in anterior chamber depth.(16)
We also measured the Uncorrected Visual Acuity (UCVA) before and after the surgery at 4 weeks, 8 weeks and 12 weeks. The UCVA improved drastically post operatively in all the groups; however, there was no significant difference between the three groups in terms of UCVA.
The strength of our study is a decent sample size to compare the effect of white-to-white corneal diameter on surgically induced astigmatism. The limitation of our study is that it doesn't compare the different types of incision width and location in each group, which may require further research.

5. CONCLUSION

Surgically induced astigmatism is an important parameter for post operative visual gain. It is a complex issue where various parameters need to be considered like placement of incisions, pre-operative astigmatism, corneal thickness, and corneal diameter. Our study found that 2.8 mm clear corneal phacoemulsification surgery in cases with a smaller corneal causes high surgically induced astigmatism as compared to bigger corneal diameters. Though, there was no statistically significant difference between the small or large corneal diameter eyes in terms of Uncorrected Visual Acuity (UCVA) after the surgery. Further research is required to evaluate the different location and width of incision related surgically induced astigmatism in small and large white to white diameter eyes.

6. BIBLIOGRAPHY

1. Rainer G, Menapace R, Vass C, Annen D, Findl O, Schmetterer K. Corneal shape changes after temporal and superolateral 3.0 mm clear corneal incisions. J Cataract Refract Surg. 1999 Aug;25(8):1121–6.
2. Barequet IS, Yu E, Vitale S, Cassard S, Azar DT, Stark WJ. Astigmatism outcomes of horizontal temporal versus nasal clear corneal incision cataract surgery. J Cataract Refract Surg. 2004 Feb;30(2):418–23.
3. Kohnen S, Neuber R, Kohnen T. Effect of temporal and nasal unsutured limbal tunnel incisions on induced astigmatism after phacoemulsification. J Cataract Refract Surg. 2002 May;28(5):821–5.
4. Lyhne N, Krogsager J, Corydon L, Kjeldgaard M. One year follow-up of astigmatism after 4.0 mm temporal clear corneal and superior scleral incisions. J Cataract Refract Surg. 2000 Jan;26(1):83–7.
5. Simşek S, Yaşar T, Demirok A, Cinal A, Yilmaz OF. Effect of superior and temporal clear corneal incisions on astigmatism after sutureless phacoemulsification. J Cataract Refract Surg. 1998 Apr;24(4):515–8.
6. Woo SJ, Lee JH. Effect of central corneal thickness on surgically induced astigmatism in cataract surgery. J Cataract Refract Surg. 2003 Dec;29(12):2401–6.

ISSN: 0975-3583, 0976-2833 VOL 14, ISSUE 06, 2023

7. Özyol E, Özyol P. The relation between superior phacoemulsification incision and steep axis on astigmatic outcomes. Int Ophthalmol. 2012 Dec;32(6):565–70.
8. Theodoulidou S, Asproudis I, Kalogeropoulos C, Athanasiadis A, Aspiotis M. Corneal Diameter as a Factor Influencing Corneal Astigmatism After Cataract Surgery. Cornea. 2016 Jan;35(1):132–6.
9. Lindstrom RL, Destro MA. Effect of incision size and Terry keratometer usage on postoperative astigmatism. J - Am Intra-Ocul Implant Soc. 1985 Sep;11(5):469–73.
10. Koch MJ, Kohnen T. Refractive cataract surgery. Curr Opin Ophthalmol. 1999 Feb;10(1):10–5.
11. Anders N, Pham DT, Antoni HJ, Wollensak J. Postoperative astigmatism and relative strength of tunnel incisions: a prospective clinical trial. J Cataract Refract Surg. 1997 Apr;23(3):332–6.
12. Singh K, Gupta S, Moulick PS, Bhargava N, Sati A, Kaur G. Study of distribution of white-to-white corneal diameter and anterior chamber depth in study population obtained with optical biometry using intraocular lens (IOL) master. Med J Armed Forces India. 2019 Oct;75(4):400–5.
13. Wei L, He W, Meng J, Qian D, Lu Y, Zhu X. Evaluation of the White-to-White Distance in 39,986 Chinese Cataractous Eyes. Invest Ophthalmol Vis Sci. 2021 Jan 5;62(1):7.
14. Güçlü H, Akaray İ, Kaya S, Sattarpanah S, Çınar AC, Sakallıoğlu K, et al. Agreement of Anterior Segment Parameters Between Schiempflug Topography and Swept-Source Optic Coherence Based Optic Biometry in Keratoconus and Healthy Subjects. Eye Contact Lens. 2021 Oct 1;47(10):539–45.
15. Hashemi H, Khabazkhoob M, Emamian MH, Shariati M, Yekta A, Fotouhi A. White-to-white corneal diameter distribution in an adult population. J Curr Ophthalmol. 2015 Oct 19;27(1–2):21–4.
16. Hashemi H, KhabazKhoob M, Yazdani K, Mehravaran S, Mohammad K, Fotouhi A. White-to-white corneal diameter in the Tehran Eye Study. Cornea. 2010 Jan;29(1):9–12.