https://doi.org/10.3329/cbmj.v12i1.64277

Effects of Corneal Incision on Steep Meridian with Preexisting Astigmatism in Cataract Surgery by Phacoemulsification

*Hasan MM[1], Begum H[2], Hasan AKMR[3]

Abstract

A cross-sectional, descriptive study was conducted in the Department of Ophthalmology, Combined Military Hospital (CMH), Dhaka Cantonment, Bangladesh, between November 2017 and May 2018, to assess the keratometric results of clear corneal incision on the steep meridian in patients with preoperative astigmatism during phacoemulsification cataract surgery. After obtaining written informed consent, a total of 40 cataract patients with age ranged between 40 and 70 years were selected. All patients were examined pre- and post-operatively after 1 week and 3 months for evaluation of astigmatism. Keratometry was done by using an autorefractometer and an autokeratometer. Astigmatism was calculated from keratometric data using vector analysis. The mean age of the study participants was 52±9.1 years. Male predominance was observed as male-female ratio was 1.7:1. The change in astigmatism in between pre- and post-operative were 0.44±0.20 in temporal incision group and 0.19±0.00 in superior incision group; both were statistically significant (P<0.001). The difference in mean astigmatism between the groups was 0.375 (P<0.001). Postoperative astigmatism <0.5D was observed in 16(40%) patients when incision was given at temporal site and in 8(20%) patients when incision was given at superior site. Astigmatism was significantly (P<0.05) decreased more when incision given at temporal site in comparison to superior site. Our data suggest that preexisting astigmatism was significantly decreased postoperatively in majority of patients when incision was placed on steep meridian and temporal incision has less surgically induced astigmatism than superior incision.

CBMJ 2023 January: vol. 12 no. 01 P: 27-32

Keywords: Cataract surgery, phacoemulsification, astigmatism, corneal incision, steep meridian

Introduction

Cataract is the principal cause of avoidable blindness worldwide.[1] The main objective of cataract surgery is to achieve a better unaided visual acuity with rapid postsurgical recovery and minimal surgery-related complications.[2] Even in an uneventful cataract surgery, surgically induced astigmatism (SIA) remains the major barrier in achieving good unaided visual acuity post-surgery to date. If preceding corneal astigmatism is not corrected at the time of surgery, it will result in more postoperative astigmatism.[3]

Postoperative SIA depends on location and size of incision, wound compression, wound gaping and wound misalignment, the surgeon's position and comfort during the procedure, the surgical skill, accuracy of biometry are to a great extent on the residual astigmatism.[4] Suture induced astigmatism also arise from suture tension and tissue oedema.[5] A suture less, clear corneal incision (CCI) during phacoemulsification has

1. *Lt Col. (Dr.) Mohammad Mahbubul Hasan, Classified Specialist, Department of Ophthalmology, Combined Military Hospital (CMH), Dhaka Cantonment, Dhaka-1206.
2. Dr. Hasiba Begum, Ex-Assistant Registrar, Department of Ophthalmology, Medical College for Women & Hospital. Uttara, Dhaka-1230.
3. Lt. Col. (Dr.) A.K.M. Rashed-ul-Hasan, Classified Specialist, Department of Ophthalmology, Combined Military Hospital (CMH), Dhaka Cantonment, Dhaka-1206.

Address of Correspondence:
Email: mahbub101171@gmail.com

become the standard treatment option for reducing SIA and correcting preexisting astigmatism.[6,7]

Nielsen stated that corneal astigmatism can be reduced by locating the incision on the steep meridian since corneal incisions flatten the incised meridian.[8]

Piao & Joo reported that corneal incision on steepest meridian in phacoemulsification is effective in mild degree corneal astigmatism (up to 1D), while higher degree of astigmatism may need different method of intervention to be more effective in correction of astigmatism.[9] Rho & Joo stated that corneal incision on steep meridian significantly decreased keratometric astigmatism.[6]

However, data are still inadequate to reach a conclusion. Moreover, there is a scarcity of literature on this issue in our country. Therefore, the present study was carried out to assess the keratometric results of clear corneal incision on the steep meridian in patients with preoperative astigmatism during cataract surgery using phacoemulsification procedure.

Methods

This cross-sectional, descriptive study was conducted in the Department of Ophthalmology, Combined Military Hospital (CMH), Dhaka Cantonment, Bangladesh, between November 2017 and May 2018. After obtaining written informed consent, a total of 40 cataract patients with age ranged between 40 and 70 years were selected. Anterior segment and posterior segment were examined. Visual acuity and extra-ocular muscle balance, retinal and macular functions tests were done. Intra ocular pressure was measured, and sac patency test was done to exclude the possible source of infection.

Keratometry was done by using an Autorefractometer (Nidek AR-1, by Nidek Co. Ltd., made in Japan) and an Autokeratometer (Grand Seiko GR-3100K, by Shigiya Machinery Works Ltd, made in Japan) to find out the K1 and K2 reading for flat and steep meridian. Astigmatism was calculated from keratometric data using vector analysis. The refractive spherical and cylindrical powers also were examined; manifest spherical equivalent was determined as the spherical power plus half of the cylindrical power. Uncorrected and best corrected visual acuity for all patients were measured in all examination visits. Subjective refraction was done for all patients with Snellen chart, trial frame and trial lens. Most of the operation was done under topical anesthesia and few with local (peribulbar) anesthesia. Standard operative procedure was followed in the phacoemulsification with posterior chamber intra ocular lens (PCIOL) implantation surgery. Incision was made at temporal and superior site of cornea according to the steep meridian. All patients were examined pre-operatively and post operatively after 1 week and 3 months for evaluation of astigmatism.

All the data were compiled, sorted properly and the quantitative data were analyzed statistically by using Statistical Package for Social Science (SPSS) version 20.0. Student's t-test was performed to compare pre- and post-operative quantitative data, while Chi-square test was done to compare qualitative data between the groups. 95% CI was calculated and $P<0.05$ were considered as the level of significance. The study was approved by the Institutional Review Board of Combined Military Hospital (CMH), Dhaka, Bangladesh.

Results

The mean age of the study participants was 52± 9.1 years. Male predominance was observed as male-female ratio was 1.7:1 (Table-I). The change in astigmatism in between pre- and post-operative were 0.44±0.20 in temporal incision group and 0.19±0.00 in superior incision group; both were statistically significant (P<0.001) (Table-II).

Table-I: Distribution of study subjects according to age and gender (n=40)

Age (Years)	
Mean±SD	52± 9.1
Range	(30-70)
Gender	
Male	25 (62.5%)
Female	15 (37.5%)

Data were expressed as Mean±SD, frequency and percentage, n=total number of participants

The difference in mean astigmatism between the groups was 0.375 (P<0.001) (Table-III). Postoperative astigmatism <0.5D was observed in 16(40%) patients when incision was given at temporal site and in 8(20%) patients when incision was given at superior site. Astigmatism was significantly (P<0.05) decreased more when incision given at temporal site in comparison to superior site (Table-IV).

Table-II: Mean pre- and post-operative astigmatism of study subjects (n=40)

Site of incision	**Astigmatism (D)**			
	Pre-operative	**Post-operative**	**Change**	**P value**
Temporal	0.63± 0.39	0.19± 0.19	0.44± 0.20	<0.001^{S}
Superior	0.75± 0.30	0.56± 0.30	0.19± 0.00	<0.001^{S}

Data were expressed as mean±SD. Paired Student's t-test was performed to reach the P value; S=significant.

Table-III: Comparison of change in astigmatism between two sites of incision (n=40)

Site of incision	**Change in Astigmatism (D)**	**P value**
Temporal vs. Superior	-0.375	<0.001^{S}

Data were expressed as mean. Unpaired Student's t-test was performed to reach the P value; S=significant.

Table-IV: Distribution of study subjects by pre- and post-operative astigmatism (n=40)

Astigmatism	**Temporal**			**Superior**		
	Preoperative	**Postoperative**	**P value**	**Preoperative**	**Postoperative**	**P value**
<0.5 D	4 (10%)	16 (40%)	<0.05^{S}	1 (2.5%)	8 (20%)	
0.5 D-1.00D	7 (17.5%)	4 (10%)		8 (20%)	8 (20%)	<0.05^{S}
1.00D-1.5 D	9 (22.5%)	0 (0%)		11 (27.5%)	4 (10%)	
Total	20	20		20	20	

Data were expressed as frequency and percentage. Chi-square test was performed to reach the P value; S=significant.

Discussion

The present study showed that the mean age of the participants was 52±9.1 years. Men had a higher incidence (62.5%) than women (37.5%); male-female ratio was 1.7:1. Khan *et al*. conducted a study to determine the mean change in pre-existing astigmatism, by site of incision in phacoemulsification and included study subjects with mean age of 59.36±10.08 years. Male were predominant gender in their study as male-female ratio was 1.2:1.[10] Another study conducted in Ghana by Arthur *et al.* reported the mean age of the subjects as 66.98±10.92 years.[11] All those findings are in congruence with our study results.

During phacoemulsification cataract surgery, incision was given at temporal and superior site. After surgery, mean postoperative astigmatism was significantly (P<0.001) decreased from their pre-operative astigmatism. Astigmatism was 0.375D (P<0.05) less when incision was given in temporal site in comparison to superior site incision. Postoperative astigmatism <0.5D was observed in 40% patients when incision was given at temporal site and in 20% patients when incision was given at superior site. Astigmatism was significantly (P<0.05) decreased more when incision given at temporal site. Khan *et al.* stated that the mean pre-operative astigmatism was 1.90±0.49 D with a range between 1.20 and 3.25 D. The astigmatism decreased in 105 eyes (92.92%), remained unchanged in 4 eyes (3.53%) and increased in 4 eyes (3.53%). The mean reduction in astigmatism at the end of study was 0.54±0.27 D. This difference in preoperative and postoperative was statistically significant (P=0.001).[10] They concluded that a 3.2 mm perpendicular incision at the steep meridian of cornea is effective in reducing the pre-existing astigmatism.[10] Thool *et al.* observed mean preoperative astigmatism as 0.79±0.26 in superior incision group and postoperatively 0.47±0.32, while the mean preoperative astigmatism in temporal incision group was 0.76±0.28 and postoperatively 0.45±0.28. Postoperative astigmatism was significantly decreased from their preoperative values in both groups (P<0.05).[12] They concluded that by placing incision on steep meridian, there was significant reduction of corneal astigmatism postoperatively in majority of patients and temporal incision has less surgically induced astigmatism than superior incision.[12] Bazzazi *et al.* reported that in their study, mean corneal astigmatism was 1.82±0.86 D in the superior group and 1.74±0.86 D in the temporal group preoperatively, which decreased to 1.31±0.59 (P=0.013) and 1.19±0.64 (P=0.009) postoperatively respectively.[13]

Overall, corneal incisions based on the steep meridian in the eyes at the temporal, superotemporal, and superior locations help significantly decrease keratometric astigmatism post-operatively; however, it is desirable to place the corneal incision on the steep meridian in eyes with corneal astigmatism >0.5D.[6] Making the incision on the steep corneal axis is the simplest method but may be difficult or impossible with certain axes. The amount of correction using this method varies but is usually reported to be <1D.[14]

Conclusion

After in-depth analysis of the results of present study, it can be concluded that pre-existing astigmatism is significantly decreased post-operatively in most of the patients when incision was placed on steep meridian in eye and in such

cases, temporal incisions have less surgically induced astigmatism than that of superior incisions given in cornea during cataract surgery. However, a large-scale study is recommended to allow the findings of the study to be generalized to our reference population.

Acknowledgement

We would like to express our gratitude to the Department of Ophthalmology, Combined Military Hospital (CMH), Dhaka, Bangladesh, for enormous co-operation received during sample collections and to all the study subjects for their sincere participation.

References

1. *Thylefors B, Négrel AD, Pararajasegaram R, Dadzie KY. Global data on blindness. Bull World Health Organ. 1995;73(1):115-21.*
2. *Weikert MP. Update on bimanual microincisional cataract surgery. Curr Opin Ophthalmol. 2006;17(1):62-7.*
3. *Bhatnagar K, Khanna A, Pujari S. Superior sclera versus temporal corneal on steep axis incision to correct pre-existing corneal astigmatism less than 1.5 D. J Ophthalmic Sci. 2015;1(1):1-8.*
4. *Chauhan RS, Goel A, Bhatnagar H, Rathi A. A Comparative evaluation of manual small incision cataract surgery and phacoemulsification with rigid posterior chamber intraocular lens. Saudi J Med Pharm Sci. 2020;6(4):359-67.*
5. *Pershing S, Kumar A. Phacoemulsification versus extracapsular cataract extraction: where do we stand? Curr Opin Ophthalmol. 2011;22(1):37-42.*
6. *Rho CR, Joo CK. Effects of steep meridian incision on corneal astigmatism in phacoemulsification cataract surgery. J Cataract Refract Surg. 2012;38(4):666-71.*
7. *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;25(8):1121-6.*
8. *Nielsen PJ. Prospective evaluation of surgically induced astigmatism and astigmatic keratotomy effects of various self-sealing small incisions. J Cataract Refract Surg. 1995;21(1):43-8.*
9. *Piao J, Joo CK. Site of clear corneal incision in cataract surgery and its effects on surgically induced astigmatism. Sci Rep. 2020;10(1):3955.*
10. *Khan A, AlamM, Afridi MR, Ahmad I. Effect of incision site on pre-existing astigmatism in phaco-emulsification. Pak J Ophthalmol. 2014;30(1):45-8.*
11. *Arthur E, Sadik AA, Kumah DB, Osae EA, Mireku FA, Asiedu FY, et al. Postoperative corneal and surgically induced astigmatism following superior approach manual small incision cataract surgery in patients with preoperative against-the-rule astigmatism. J Ophthalmol. 2016;2016:9489036.*
12. *Thool A, Daigavane S. Outcome of clear corneal incision on steep meridian in eye with pre-existing corneal astigmatism after phacoemulsification. IOSR J Dent Med Sci. 2018;17(11):11-8.*
13. *Bazzazi N, Barazandeh B, Kashani M, Rasouli M. Opposite clear corneal incisions versus steep meridian incision phacoemulsification for correction of pre-existing astigmatism. J Ophthalmic Vis Res. 2008;3(2):87-90.*

14. *Matsumoto Y, Hara T, Chiba K, Chikuda M. Optimal incision sites to obtain an astigmatism-free cornea after cataract surgery with a 3.2 mm sutureless incision. J Cataract Refract Surg. 2001;27(10):1615-9.*