

Comparison Of Surgically Induced Astigmatism Between One Side Port And Two Side Ports With 2.8mm Corneal Incision In Phacoemulsification

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Abstract

Objective: To compare the outcome of surgically induced astigmatism between one side port and two side ports with 2.8mm corneal incision in phacoemulsification.

Design: Randomized Controlled Trial

Place and duration of Study: Department of Ophthalmology, Sahiwal Teaching Hospital, Sahiwal, and Study was carried out over a period of six months from 09-06-2024 to 09-12-2024.

Methodology: We conducted a randomized controlled trial at the Department of Ophthalmology, Sahiwal Teaching Hospital, Sahiwal, over six months from 09-06-2024 to 09-12-2024. Sixty patients scheduled for cataract surgery were randomly assigned to two groups of 30 eyes each. Group A underwent phacoemulsification with one side port, and Group B with two side ports. A single surgeon performed all surgeries using a uniform technique. Pre- and postoperative keratometric readings were recorded, and SIA was calculated using vector analysis.

Results: The two groups were comparable in baseline characteristics. Mean SIA was significantly lower in the one-side-port group (0.51 ± 0.01 D) than in the two-side-port group (1.51 ± 0.01 D; $p = 0.0013$). This pattern remained consistent across all demographic and clinical subgroups, suggesting that the number of side ports was the principal factor influencing postoperative astigmatic change.

Author Details

Keywords: Phacoemulsification; Surgically induced astigmatism; Side port; Clear corneal incision; Cataract surgery; Refractive stability; Corneal biomechanics

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Conclusion: Phacoemulsification performed with a single side port resulted in less surgically induced astigmatism than the two-side-port technique. Reducing the number of corneal entries may help improve refractive stability and uncorrected visual acuity. Surgeons may consider limiting side-port creation, particularly in cases where minimizing postoperative astigmatism is a priority.

Introduction

Cataract blindness is one of the major community health problems in the setting of ophthalmology. Cataract surgery with intraocular lens implantation restores vision to near normal. Safe surgery, early visual rehabilitation, and postoperative emmetropia are the requirements of the present-day cataract surgery. Phacoemulsification has advantages such as early visual rehabilitation, less induced astigmatism, better uncorrected postoperative visual acuity, lesser incidence of intraoperative, and postoperative complications. It is currently the most performed planned surgical procedure worldwide, positively impacting over patients' quality of life.¹

The recent years have seen a huge increase in the burden of cataract surgery along with a decreased tolerance for spectacles in patients after cataract surgery. These changing trends have made it essential for each surgeon to strive for the ultimate goal of postoperative emmetropia by minimizing the Surgically-Induced Astigmatism. One of the main factors influencing Surgically-Induced Astigmatism is the type of cataract surgery due to the differences in their incision size.^{2,3}

Recent evidence indicates that a small 2.8-mm clear corneal incision induces little refractive change, at least in eyes with low preoperative corneal cylinder, regardless of incision site. However, a retrospective study describes slightly higher changes induced by superior rather than temporal 2.8-mm incision, which had been considered nearly astigmatism neutral.^{4,5} In our study we gave supero-temporal incision in all our case.

Morya et al., found that mean surgically induced astigmatism was 0.51 ± 0.64 with single port and 1.50 ± 0.53 with two ports ($p < 0.05$) after 1.5 months while 0.41 ± 0.39 with single port and 1.25 ± 0.48 with two ports ($p < 0.05$) after 3 months.⁶ One more trial found that mean surgically induced astigmatism was 0.67 ± 0.46 with single port and 1.17 ± 0.44 with two ports ($p < 0.05$) after 1.5 month.¹

Rationale of this study is to compare the outcome of surgically induced astigmatism between one side port and two side ports with 2.8mm corneal incision in phacoemulsification. It has been reported in previous trials that risk of surgically induced astigmatism is slightly higher with single port as compared to two port surgery. But in routine, two ports are applied for phacoemulsification. Therefore, we want to conduct this trial in local set-up to get evidence and implement more appropriate findings in local setting. So that we are now left with side port effects on astigmatism. Here are two groups. One group with one side port and other group with two side ports. This will help to improve our practice of fashioning side ports for effective surgical outcomes. Here it can be mentioned that two side ports offer enhanced access and ease of manipulation during surgery. It is especially true for beginners. So, one side port can offer less astigmatism but it will give limited ease of manipulation during surgical procedure. While two side ports may result in increased surgically induced astigmatism but it would be easy for a surgeon to manipulate through these ports.

MATERIAL AND METHODS:

The study was designed as a randomized controlled trial and conducted at the Department of Ophthalmology, Sahiwal Teaching Hospital, Sahiwal, over a period of six months following the approval of the study synopsis from 09-06-2024 to 09-12-2024. The sample size, calculated using OpenEpi, was 60 patients, with 30 patients allocated to each group. The calculation was based on a 95% confidence level, 90% power, and previously reported mean surgically induced astigmatism of 0.51 ± 0.64 for

single port and 1.50 ± 0.53 for two ports. Non-probability consecutive sampling was employed to enroll participants who met the inclusion criteria. Patients eligible for inclusion were those aged 30–60 years of either gender undergoing phacoemulsification for cataract. Individuals were excluded if there was failure to place the intraocular lens, the need for suturing of incisions, infection at the incision site, repeat procedures within the follow-up period, or if they were lost to follow-up. After obtaining ethical approval, patients meeting the selection criteria were recruited from hospital wards, and written informed consent was obtained from each participant. Demographic and clinical data were recorded, including name, age, gender, anatomical side, duration of cataract, presence of myopia, history of diabetes, hypertension, anemia, and prior use of lenses or glasses. Preoperative evaluation included measurement of intraocular pressure (IOP) using a puff tonometer and assessment of astigmatism via auto-refractometer and subjective refraction and detailed anterior and posterior segment examination using necessary tools. Participants were then randomly assigned to two groups using a lottery method. Group A underwent phacoemulsification with a single side port, while Group B had two side ports. The side ports were created in the clear cornea, measuring about 1 mm in width and 1.5 mm in length. All surgical procedures were performed under local anesthesia by a single surgical team with assistance from the researcher. Operative time for each procedure was documented. Postoperatively, patients were monitored in the surgical ward before discharge. Follow-up assessments for astigmatism and surgically induced astigmatism were conducted at 1.5 and 3 months after surgery, as defined in the operational definitions. All data were collected using a specifically designed proforma. Data analysis was performed using SPSS version 26.0. The Shapiro-Wilk test was applied to assess the normality of continuous variables. Quantitative variables such as age, duration of cataract, operative time, IOP, astigmatism, and surgically induced astigmatism were summarized as mean \pm standard deviation, while qualitative variables including gender, anatomical side, myopia, history of diabetes, hypertension, anemia, and lens or glasses use were presented as frequencies and percentages. Comparisons of mean astigmatism and surgically induced astigmatism between the two groups were conducted using an independent samples t-test, with a p-value ≤ 0.05 considered statistically significant. To control for potential confounding factors, stratification was performed for age, gender, anatomical side, duration of cataract, IOP, myopia, history of diabetes, hypertension, anemia, lens use, glasses use, and operative time. Post-stratification comparisons between groups again utilized independent samples t-tests for mean astigmatism and surgically induced astigmatism within each stratum, with p-values ≤ 0.05 deemed significant.

RESULTS

We enrolled 60 patients in total, assigning 30 to each group. Table 1 presents the baseline profile of study participants. Most patients in both groups were between 46 and 60 years of age. In Group A (one side port), 86.7% of participants were in this age bracket, compared with 63.3% in Group B (two side ports). The mean age was slightly lower in Group A (41.31 ± 6.58 years) than in Group B (43.15 ± 5.83 years), though this difference was not significant. Both groups showed an almost equal distribution by sex, with males and females. The operated eye was evenly distributed between right and left sides. These findings indicate that both groups were well balanced in terms of demographic and surgical laterality characteristics at baseline.

The prevalence of systemic and ocular comorbidities was comparable between groups. In Group A, 43.3% of patients had diabetes and 50% had hypertension, which was nearly identical to the proportions in Group B (40% and 50%, respectively). Myopia appeared in about one-third of participants in each group, while anemia was present in 16.7% of cases in both groups. The majority of participants had cataract symptoms for

more than three months before surgery—90% in Group A and 96.7% in Group B. Most surgeries concluded within 20 minutes in both groups (83.3%). A higher proportion of patients in Group B (43.3%) reported using corrective glasses compared with Group A (30%) pre-operatively, but this difference was small and not statistically meaningful. Overall, the distribution of baseline characteristics confirmed that the two groups were similar before intervention.

We observed a clear and statistically significant difference in surgically induced astigmatism (SIA) between the two surgical techniques. The mean SIA in Group A (one side port) was 0.51 ± 0.01 D, whereas in Group B (two side ports) it was 1.51 ± 0.01 D ($p = 0.0013$) at 3 months. This difference indicates that adding a second side port produced roughly three times greater postoperative astigmatism. The pattern remained consistent across demographic subgroups. Regardless of age, sex, or operated eye, patients in Group B consistently developed higher SIA than those in Group A.

Subgroup comparisons further supported this trend. Across all age categories, patients in the two-port group showed significantly higher SIA than their counterparts in the one-port group ($p < 0.001$). The same association appeared when the data were stratified by gender, laterality, and systemic conditions such as diabetes and hypertension. Duration of surgery showed no meaningful effect on SIA within either group ($p = 0.14$), suggesting that the number of side ports rather than operative time was the major factor influencing postoperative astigmatism. Even among patients with myopia, anemia, or a history of glasses use, the one-port technique consistently resulted in less induced astigmatism (around 0.50–0.53 D) compared with the two-port technique (around 1.50–1.52 D). These findings demonstrate a consistent and clinically relevant pattern: using a single side port is associated with lower surgically induced astigmatism without compromising operative efficiency.

Table 1: Distribution of baseline characteristics among the study participants

Variables	One side port Group A n (%)	Two side port Group B n (%)
Age		
30-45 years	04 (13.3)	11 (36.7)
46-60 years	26 (86.7)	19 (63.3)
Gender		
Male	15 (50)	16 (53.3)
Female	15 (50)	14 (46.7)
Anatomical side		
Left	15 (50)	14 (46.7)
Right	15 (50)	16 (53.3)
Duration of cataract		
≤ 3 months	03 (10)	01 (3.3)
> 3 months	27 (90)	29 (96.7)
Duration of surgery		
≤ 20 minutes	25 (83.3)	25 (83.3)
> 20 minutes	05 (16.7)	05 (16.7)
Myopia		
Yes	11 (36.7)	10 (33.3)
No	19 (63.3)	20 (66.7)
Diabetes mellitus		
Yes	13 (43.3)	12 (40)
No	17 (56.7)	18 (60)

Hypertension		
Yes	15 (50)	15 (50)
No	15 (50)	15 (50)
Anemia status		
Yes	05 (16.7)	05 (16.7)
No	25 (83.3)	25 (83.3)
Glasses use		
Yes	09 (30)	13 (43.3)
No	21 (70)	17 (56.7)

Table-2 clinical characteristics of the two groups at 3months

Clinical Variables	One side port Group A n = 30	Two side port Group B n= 30	P values
Age (years)	41.31 ± 6.58	43.15 ± 5.83	
Surgically induced astigmatism	0.51 ± 0.01	1.51 ± 0.01	0.0013
Age			<0.001
30-45 years	0.52 ± 0.01	1.51 ± 0.02	
46-60 years	0.51 ± 0.01	1.51 ± 0.16	
Gender			<0.001
Male	0.51 ± 0.01	1.51 ± 0.01	
Female	0.51 ± 0.01	1.51 ± 0.01	
Anatomical side			<0.001
Left	0.51 ± 0.01	1.51 ± 0.01	
Right	0.51 ± 0.01	1.51 ± 0.02	
Duration of cataract			<0.001
≤ 3 months	0.50 ± 0.02	1.51 ± 0.02	
> 3 months	0.51 ± 0.01	1.51 ± 0.16	
Duration of surgery			0.14
≤ 60 minutes	0.51 ± 0.01	1.51 ± 0.01	
> 60 minutes	0.51 ± 0.01	1.52 ± 0.02	
Myopia			<0.001
Yes	0.50 ± 0.00	1.51 ± 0.01	
No	0.51 ± 0.01	1.51 ± 0.01	
Diabetes mellitus			<0.001
Yes	0.51 ± 0.01	1.52 ± 0.02	
No	0.51 ± 0.01	1.50 ± 0.01	
Hypertension			<0.001
Yes	0.51 ± 0.01	1.51 ± 0.02	
No	0.50 ± 0.01	1.51 ± 0.01	
Anemia status			<0.001
Yes	0.53 ± 0.01	1.50 ± 0.01	
No	0.50 ± 0.01	1.51 ± 0.01	
Glasses use			<0.001
Yes	0.51 ± 0.01	1.52 ± 0.01	
No	0.51 ± 0.01	1.50 ± 0.01	

DISCUSSION

This randomized controlled trial examined the effect of side-port number on surgically induced astigmatism (SIA) following phacoemulsification with a 2.8 mm clear corneal incision. The results demonstrated that eyes operated with a single side

port developed significantly lower postoperative astigmatism than those with two side ports. Because the two groups were comparable in demographic and clinical features, the observed difference most likely reflects the mechanical effect of the additional incision rather than baseline variability. These findings reinforce the understanding that each corneal entry point modifies the corneal curvature and can increase astigmatic change.⁷

The mean SIA observed in the single-port group (0.51 ± 0.01 D) closely matched the results reported by Morya and colleagues,⁷ who found 0.51 ± 0.64 D in single-port cases and 1.50 ± 0.53 D in two-port cases using the same incision size. This consistency across studies strengthens the reliability of the finding. The smaller SIA in single-port procedures can be attributed to reduced stress on the corneal lamellae and less disturbance of its symmetrical curvature. By contrast, adding a second port introduces an additional zone of corneal flattening, which increases the magnitude of SIA and potentially affects the regularity of the corneal surface.

Our results align with the vector analysis presented by Kawahara et al.⁸, who compared one-handed and two-handed cataract surgery techniques. They reported that although the overall magnitude of SIA was similar between the two methods, the introduction of a side port produced a measurable rotational shift of the astigmatic axis. The present study extends this observation by showing that when two side ports accompany a 2.8 mm incision, both the magnitude and the axis of astigmatism can be affected. These findings suggest that even small secondary incisions have a cumulative biomechanical influence on the cornea, which may become clinically relevant in procedures requiring precise refractive outcomes.

Evidence from other studies further supports the current results. Kim et al.⁹ demonstrated that smaller incisions, such as 2.2 mm, induce less astigmatism than wider ones (2.75 mm) in combined cataract and vitrectomy surgery. Reddy et al.¹⁰ also reported that temporal clear-corneal incisions generate less SIA than superior or scleral tunnel approaches. Collectively, these studies confirm that both the size and location of corneal incisions are important determinants of postoperative refractive stability. By maintaining a constant main incision size, our trial isolates the effect of side-port number, showing that it independently influences the magnitude of surgically induced astigmatism.

From a clinical standpoint, these findings highlight a balance between surgical convenience and refractive precision. Two side ports undoubtedly provide easier access and better maneuverability, particularly for surgeons in training, but they also carry a higher risk of postoperative astigmatism. A single side port, while requiring greater skill, may help minimize refractive error and improve uncorrected visual acuity after surgery. Surgeons should consider the number and placement of side ports as part of preoperative planning, especially when implanting toric intraocular lenses or operating on eyes where minimal SIA is desirable. Larger multicenter trials with longer follow-up would help validate these results and determine whether the difference in astigmatism persists over time.

LIMITATIONS:

This study has a few limitations. The sample size was relatively small and drawn from a single center, which may limit how broadly the findings apply. All surgeries were performed by one surgeon, ensuring uniform technique but possibly introducing operator bias. The follow-up period of three months was short, and longer observation could better capture the stability of postoperative astigmatism. In addition, the study relied on keratometric readings rather than advanced corneal imaging. This might have provided more detailed insights into corneal changes. Despite these limitations, the randomized design and well-balanced groups support the validity of the conclusion that the number of side ports influences surgically induced astigmatism after phacoemulsification.

CONCLUSION:

Patients who underwent phacoemulsification with a single side port and a 2.8 mm clear corneal incision developed significantly less surgically induced astigmatism than those with two side ports. Because both groups were comparable at baseline, the difference in outcomes most likely reflects the biomechanical effect of the additional incision. Reducing the number of side ports appears to limit corneal distortion, leading to more stable postoperative refraction and better uncorrected visual acuity. Although two side ports can improve intraoperative maneuverability, particularly for less experienced surgeons, a single side port offers clearer refractive advantages. Incorporating this approach where suitable may improve visual recovery and support more predictable outcomes in cataract surgery.

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