



Comparison of Postoperative Visual Outcomes Following Superior Vs Temporal Approach Phacoemulsification with Foldable and Non-Foldable Intraocular Lens Implantation

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Abstract

Background: This study was conducted to compare postoperative visual outcomes following superior vs temporal approach phacoemulsification with foldable and non-foldable intraocular lens implantation

Materials and Methods: The study included 260 patients undergoing phacoemulsification with intraocular lens (IOL) implantation, randomly assigned to four groups based on surgical approach and lens type. Group 1 (n = 100) received superior approach phacoemulsification with foldable IOL (6 mm optic), and Group 2 (n = 30) received superior approach with non-foldable IOL (5.25 mm optic). Group 3 (n = 100) underwent temporal approach with foldable IOL and Group 4 (n = 30) underwent temporal approach with non-foldable IOL. Postoperative visual outcomes and astigmatism were assessed at day 7, day 30, and at 3, and 6 months. All data were systematically recorded for subsequent analysis.

Results: The study included four groups with comparable demographics. Preoperatively, most patients had uncorrected visual acuity (UCVA) <6/24. Postoperatively, all groups demonstrated significant improvement, with the majority achieving UCVA of 6/6-6/9 at successive follow-ups. At six months, UCVA of 6/6-6/9 was observed in 78%, 60%, 82%, and 70% of patients in groups 1-4, respectively, without significant intergroup differences ($p > 0.05$). Best-corrected visual acuity (BCVA) also improved significantly, with 98%, 93.3%, 98%, and 96.7% achieving 6/6-6/9 in groups 1-4 ($p > 0.05$). Near vision (BCNVA) was comparable among groups (N6: 88%, 83.3%, 89%, 86.7%; $p = 0.868$).

Preoperative corneal astigmatism was similar across groups (0.68-0.86 D; $p > 0.05$). Postoperatively, an initial rise in astigmatism was observed, followed by gradual reduction. At six months, mean astigmatism was 0.89, 1.53, 0.68, and 1.02 D for groups 1-4, with significant differences between superior versus temporal approaches and foldable versus non-foldable lenses ($p < 0.05$ / $p < 0.001$). Astigmatism reduction remained significant throughout follow-up in groups 1, 2, and 4, while group 3 showed non-significant changes from two months onward.

Conclusion: Both superior and temporal approaches with foldable and non-foldable IOLs resulted in comparable UCVA and BCVA outcomes over the follow-up period. However, a significant difference was observed in terms of postoperative astigmatism. Postoperative astigmatism was found to be comparatively lower in the temporal approach and in eyes implanted with foldable intraocular lenses. Among all groups, the temporal foldable group (Group 3) demonstrated the least surgically induced astigmatism, with values approaching preoperative levels and becoming statistically non-significant from two months onwards.

Keywords: Cataract; Phacoemulsification; Foldable IOL; Non Foldable IOL

Introduction

Cataract, defined as any opacity of the crystalline lens, leads to reduced light transmission and consequent visual impairment [1]. It remains the leading cause of blindness worldwide, accounting for approximately 51% of global blindness and 33% of visual impairment [2]. Cataract formation is multifactorial in origin, with ageing being the most common cause, although systemic diseases, trauma, medications, and genetic factors also contribute [3].

Surgical removal of the opacified lens with intraocular lens (IOL) implantation is the only definitive treatment. Cataract surgery has evolved considerably over time. Intracapsular cataract extraction, widely practiced before World War II, involved removal of the entire lens and capsule through a large limbal incision [4]. This was later replaced by extracapsular cataract extraction (ECCE), which utilized a smaller incision and preserved the posterior capsule [4].

Currently, phacoemulsification is the preferred technique due to its safety and rapid postoperative recovery. Introduced by Charles D. Kelman in 1967, it involves ultrasonic emulsification of the lens nucleus using a vibrating titanium probe, followed by aspiration of lens material [5]. Compared to ECCE, phacoemulsification offers advantages such as smaller incision size, reduced intraoperative complications, and faster visual rehabilitation [6]. Surgical outcomes are influenced by factors including incision type, surgical approach, and IOL characteristics [7].

Three kinds of phacoemulsification incisions exist: sclerocorneal, limbal, and clear corneal incisions, with the latter being most commonly used due to minimal postoperative inflammation, reduced pain, and lower surgically induced astigmatism (SIA) [8]. These incisions are typically bloodless, self-sealing, and sutureless, although larger wounds may compromise wound integrity and increase endothelial cell loss [8].

Incision placement plays a crucial role in surgical outcomes. Superior and temporal approaches are most frequently employed, while nasal incisions are less favored due to higher SIA and technical difficulty [9]. The superior approach offers advantages such as reduced patient discomfort due to the incision being covered by the upper eyelid and improved surgical stability, as the surgeon's hand can rest on the patient's forehead [10]. However, access may be limited in patients with deep-set eyes due to obstruction by the orbital rim.

In contrast, the temporal approach provides better exposure of the surgical field and eliminates concerns related to Bell's phenomenon when topical anaesthesia is used. Additionally, it preserves the superior and supero-temporal sclera for potential future trabeculectomy. However, it requires appropriate adjustment of the surgical setup depending on whether the right or left eye is being operated.

Advances in IOL design have further enhanced surgical outcomes. Since the first IOL implantation by Sir Harold Ridley in 1949, significant progress has been made from rigid polymethyl methacrylate (PMMA) lenses to modern foldable lenses made of silicone and acrylic [11]. The advent of foldable IOLs, composed of acrylic or silicone, facilitates small-incision, self-sealing surgery, whereas rigid PMMA lenses necessitate larger incisions and suturing [12].

Postoperative refractive status is determined by IOL power and surgically induced changes in corneal curvature [13]. SIA results from biomechanical alterations in the cornea following incision and wound healing and significantly affects visual outcomes [14]. Its magnitude depends on incision size, location, and surgical technique [15]. Strategic placement of incisions along the steepest corneal meridian can help reduce pre-existing astigmatism, thereby enhancing refractive outcomes [16]. Consequently, modern cataract surgery is increasingly regarded as a refractive procedure aimed at both visual rehabilitation and correction of refractive errors [17].

Aim of the Study

This study aims to compare postoperative visual outcomes following superior versus temporal approach phacoemulsification with foldable and non-foldable IOL implantation, elucidating the impact of incision site and lens type on refractive results.

Materials and Methods

A total of 260 patients who were advised phacoemulsification with intraocular lens implantation were included and assessed for postoperative visual outcomes. Patients were randomly divided into 4 groups, according to the type of approach of phacoemulsification and type of lens used. The foldable IOL used in the study is Supra Phob hydrophobic IOL (SPNT300, Appasamy Ocular Devices (P) Ltd., Vadamanlam, Puducherry, India) and non-foldable IOL used

in the study is Appalens IOL (101, Appasamy Ocular Devices (P) Ltd., Vadamanglam, Puducherry, India).

The inclusion criteria were; patients aged between 40 - 90 years, patients with uncomplicated cataract, patients undergoing uneventful phacoemulsification cataract surgery and patients willing for follow-up on post operative days 7, 30, 3 months and 6 months. Patients with previous history of intraocular surgery, patients undergoing complicated cataract surgery where in the bag implantation of IOL was not performed or surgery converted to manual small incision cataract surgery, patients with any active ocular disease such as uveitis, diabetic retinopathy, glaucoma, age related macula degeneration, patients with corneal disease like Fuch's endothelial dystrophy, corneal stromal scarring and high ametropia (biometry for emmetropia <17.0D,>26.0D) were excluded from the study.

The group-wise distribution of subjects was as follows:

1. **Group 1:** Patients underwent superior approach phacoemulsification with foldable IOL (6 mm optic size) implantation (100 patients).
2. **Group 2:** Patients underwent superior approach phacoemulsification with non- foldable IOL (5.25 mm optic size) implantation (30 patients).
3. **Group 3:** Patients underwent temporal approach phacoemulsification with foldable IOL (6mm optic size) Implantation (100 patients).
4. **Group 4:** Patients underwent temporal approach phacoemulsification with non- foldable IOL (5.25 mm optic size) implantation (30 patients).

Surgical procedure

All surgeries were performed under local anesthesia using a combination of peribulbar and facial nerve block. After topical antibiotic prophylaxis and adequate pupillary dilatation, a wire speculum was applied, side-port incisions were made, and a 2.8 mm self-sealing clear corneal incision was created using a keratome. Superior incisions were placed at the 12 o'clock position, and temporal incisions at 3 o'clock. The anterior capsule was stained with trypan blue, the anterior chamber maintained with viscoelastic, and continuous curvilinear capsulorrhexis was performed. Following hydrodissection and hydrodelineation, the nucleus was emulsified and aspirated, and residual cortical material removed. Capsular bag polishing was performed as required.

Foldable IOLs were implanted through the 2.8 mm incision using an injector system, while non-foldable IOLs required enlargement of the incision to 5.25 mm. Residual viscoelastic was removed, and incisions were sealed by stromal hydration. Subconjunctival antibiotic and steroid injections were administered, and the eye was padded. Postoperatively, a topical antibiotic-steroid combination was prescribed and gradually tapered over six weeks. All patients were followed according to the study protocol to assess postoperative visual outcomes and surgically induced astigmatism.

Results

The majority of patients across all four groups belonged to the age group of 51-70 years, which is consistent with the typical age distribution of senile cataract. The mean age in group 1 was 60.06 ± 10.37 years, in group 2 was 61.60 ± 8.73 years, in group 3 was 59.65 ± 9.11 years, and in group 4 was 62.37 ± 8.05 years. Statistical analysis showed no significant difference among the groups ($F = 0.841$, $p = 0.473$) (Table 1).

Age Group (Years)	Group 1		Group 2		Group 3		Group 4	
	Patients	Percentage	Patients	Percentage	Patients	Percentage	Patients	Percentage
41 - 50	24	24%	5	16.67%	17	17%	3	10%
51 - 60	28	28%	8	26.67%	30	30%	12	40%
61 - 70	37	37%	14	46.67%	43	43%	11	36.67%
≥ 71	11	11%	3	10%	10	10%	4	13.33%
Total	100	100%	30	100%	100	100%	30	100%
Mean ± SD	60.06 ± 10.37 years		61.60 ± 8.73 years		59.65 ± 9.11 years		62.37 ± 8.05 years	
Median	60.00 years		62.50 years		62.00 years		60.50 years	
Range	41 - 82 years		45 - 77 years		41 - 80 years		45 - 76 years	
F value	0.841							
p value	0.473 (NS)							

Table 1

Out of the total study population, 143 patients (55%) were females and 117 patients (45%) were males and there was no gender predilection.

Among the total cases, 134 (51.54%) underwent surgery for right eye cataract whereas 126 (48.46%) were operated for left eye cataract. There was no eye predilection in this study ($\chi^2 = 0.42$, $p = 0.518$).

On postoperative day 7, a marked improvement in UCVA was observed in all groups, with 60% (Group 1), 43.33% (Group 2), 65% (Group 3), and 50% (Group 4) achieving 6/6-6/9 vision. However, the intergroup difference was not statistically significant ($p = 0.132$) (Table 2).

UCVA	Group 1		Group 2		Group 3		Group 4		p value (Kruskal Wallis Test)	GP 1 vs GP 2	GP 1 vs GP 3	GP 2 vs GP 4	GP 3 vs GP 4
	Pa-tients	Per-centage	Patients	Percent-age	Pa-tients	Per-cent-age	Pa-tients	Percent-age					
6/6-6/9	60	60%	13	43.33%	65	65%	15	50%	0.132; NS (5.611)	0.144; NS (1.460)	0.348; NS (0.939)	0.559; NS (0.584)	0.136; NS (1.489)
6/12-6/18	31	31%	14	46.67%	31	31%	13	43.33%					
6/24-6/36	9	9%	3	10%	4	4%	2	6.67%					
≤6/60	0	0%	0	0%	0	0%	0	0%					
Total	100	100%	30	100%	100	100%	30	100%					

Table 2: Postoperative analysis of UCVA at day 7.

Postoperative BCVA showed excellent improvement in all groups as early as day 7. On day 7, 91% (Group 1), 86.67% (Group 2), 92% (Group 3), and 90%

(Group 4) achieved BCVA of 6/6-6/9, with no statistically significant difference ($p = 0.848$) (Table 3).

BCVA	Group 1		Group 2		Group 3		Group 4		Kruskal Wallis Test (p value)	GP 1 vs GP 2	GP 1 vs GP 3	GP 2 vs GP 4	GP 3 vs GP 4
	Pa-tients	Percent-age	Pa-tients	Per-centage	Pa-tients	Per-centage	Patients	Per-centage					
6/6-6/9	91	91%	26	86.67%	92	92%	27	90%	0.848; NS (0.808)	0.691; NS (0.489)	0.800; NS (0.253)	0.399; NS (0.690)	0.731; NS (0.344)
6/12-6/18	9	9%	4	13.33%	8	8%	3	10%					
6/24-6/36	0	0%	0	0%	0	0%	0	0%					
≤6/60	0	0%	0	0%	0	0%	0	0%					
Total	100	100%	30	100%	100	100%	30	100%					

Table 3: Postoperative analysis of BCVA at day 7.

At one month, the proportion of patients achieving 6/6-6/9 UCVA further increased, reaching 71% in group 1, 53.33% in group 2, 78% in group 3, and 60% in group 4. The overall intergroup comparison was statistically significant

($p = 0.036$), suggesting relatively better uncorrected visual outcomes in temporal foldable IOL group (Table 4).

UCVA	Group 1		Group 2		Group 3		Group 4		p value (Kruskal Wallis Test)	GP 1 vs GP 2	GP 1 vs GP 3	GP 2 vs GP 4	GP 3 vs GP 4
	Pa-tients	Per-cent-age	Pa-tients	Per-cent-age	Pa-tients	Per-cent-age	Pa-tients	Per-cent-age					
6/6-6/9	71	71%	16	53.33%	78	78%	18	60%	0.036; S (8.571)	0.074; NS (1.786)	0.240; NS (1.176)	0.553; NS (0.593)	0.052; NS (1.945)
6/12-6/18	25	25%	12	40%	20	20%	11	36.67%					
6/24-6/36	4	4%	2	6.67%	2	2%	1	3.33%					
≤6/60	0	0%	0	0%	0	0%	0	0%					
Total	100	100%	30	100%	100	100%	30	100%					

Table 4: Postoperative analysis of UCVA 1 month.

In group 1, 96% of patients had BCVA between 6/6-6/9 and 4% between 6/12-6/18 at postoperative month 1. In group 2, 93.33% patients had BCVA between 6/6- 6/9 and 6.67% patients had BCVA between 6/12- 6/18. In group 3, 98% patients had BCVA between 6/6- 6/9 and 2% patients had BCVA between 6/12- 6/18. In group 4, 93.33% patients had BCVA between 6/6- 6/9 and 6.67% patients between 6/12- 6/18 at postoperative month 1 (Table 5).

BCVA	Group 1		Group 2		Group 3		Group 4		p value (Kruskal Wallis Test)	GP 1 vs GP 2	GP 1 vs GP 3	GP 2 vs GP 4	GP 3 vs GP 4
	Patients	Percent-age	Pa-tients	Percent-age	Patients	Per-cent-age	Pa-tients	Per-cent-age					
6/6-6/9	96	96%	28	93.33%	98	98%	28	93.33%	0.530; NS (2.210)	0.543; NS (0.608)	0.408; NS (0.827)	1.000; NS (0.000)	0.196; NS (1.293)
6/12-6/18	4	4%	2	6.67%	2	2%	2	6.67%					
6/24-6/36	0	0%	0	0%	0	0%	0	0%					
≤6/60	0	0%	0	0%	0	0%	0	0%					
Total	100	100%	30	100%	100	100%	30	100%					

Table 5: Postoperative analysis of BCVA at 1 month.

Although visual acuity continue to improve, overall difference among groups was not statistically significant (p value = 0.078) (Table 6).

UCVA	Group 1		Group 2		Group 3		Group 4		p value (Kruskal Wallis Test)	GP 1 vs GP 2	GP 1 vs GP 3	GP 2 vs GP 4	GP 3 vs GP 4
	Pa-tients	Per-cent-age	Patients	Percent-age	Patients	Per-cent-age	Pa-tients	Percent-age					
6/6-6/9	78	78%	18	60%	82	82%	21	70%	0.078; NS (6.806)	0.052; NS (1.945)	0.490; NS (0.690)	0.378; NS (0.882)	0.179; NS (1.342)
6/12-6/18	20	20%	11	36.67%	16	16%	9	30%					
6/24-6/36	2	2%	1	3.33%	2	2%	0	0%					
≤6/60	0	0%	0	0%	0	0%	0	0%					
Total	100	100%	30	100%	100	100%	30	100%					

Table 6: Postoperative analysis of UCVA at 3 months.

In group 1, 98% of patients had BCVA between 6/6-6/9 and 2% had BCVA between 6/12-6/18 at postoperative month 3. In group 2, 93.33% patients had BCVA between 6/6- 6/9 and 6.67% patients had BCVA between 6/12- 6/18. In group 3, 98% patients had BCVA between 6/6- 6/9 and 2% patients had BCVA between 6/12- 6/18. In group 4, 96.67% patients had BCVA between 6/6- 6/9 and 3.33% patients had BCVA between 6/12- 6/18 at postoperative month 3 (Table 7).

BCVA	Group 1		Group 2		Group 3		Group 4		p value (Kruskal Wallis Test)	GP 1 vs GP 2	GP 1 vs GP 3	GP 2 vs GP 4	GP 3 vs GP 4
	Patients	Percentage	Patients	Percentage	Patients	Percentage	Patients	Percentage					
6/6-6/9	98	98%	28	93.33%	98	98%	29	96.67%	0.529; NS (2.213)	0.196; NS (1.293)	1.000; NS (0.000)	0.557; NS (0.587)	0.671; NS (0.425)
6/12-6/18	2	2%	2	6.67%	2	2%	1	3.33%					
6/24-6/36	0	0%	0	0%	0	0%	0	0%					
≤6/60	0	0%	0	0%	0	0%	0	0%					
Total	100	100%	30	100%	100	100%	30	100%					

Table 7: Postoperative analysis of BCVA at 3 months.

By 3 and 6 months, although group 3 (temporal foldable) consistently showed the highest proportion of patients achieving 6/6-6/9 vision (82%), followed by group 1, the intergroup differences were not statistically significant ($p > 0.05$). No patient in any group had UCVA $\leq 6/60$ beyond the first postoperative week, indicating sustained visual improvement (Table 8).

UCVA	Group 1		Group 2		Group 3		Group 4		p value (Kruskal Wallis Test)	GP 1 vs GP 2	GP 1 vs GP 3	GP 2 vs GP 4	GP 3 vs GP 4
	Patients	Percentage	Patients	Percentage	Patients	Percentage	Patients	Percentage					
6/6-6/9	78	78%	18	60%	82	82%	21	70%	0.078; NS (6.806)	0.052; NS (1.945)	0.490; NS (0.690)	0.378; NS (0.882)	0.179; NS (1.342)
6/12-6/18	20	20%	11	36.67%	16	16%	9	30%					
6/24-6/36	2	2%	1	3.33%	2	2%	0	0%					
≤6/60	0	0%	0	0%	0	0%	0	0%					
Total	100	100%	30	100%	100	100%	30	100%					

Table 8: Postoperative analysis of UCVA at 6 months.

At 6 months post-operatively, excellent best corrected visual acuity was achieved in the majority of patients in all four groups. BCVA of 6/6-6/9 was observed in 98% of patients in the superior foldable group (Group 1), 93.33% in the superior non-foldable group (Group 2), 98% in the temporal foldable group (Group 3), and 96.67% in the temporal non-foldable group (Group 4). Only a small proportion of patients had BCVA in the 6/12-6/18 range (2% in group 1, 6.67% in group 2, 2% in group 3, and 3.33% in group 4) (Table 9).

BCVA	Group 1		Group 2		Group 3		Group 4		p value (Kruskal Wallis Test)	GP 1 vs GP 2	GP 1 vs GP 3	GP 2 vs GP 4	GP 3 vs GP 4
	Pa- tients	Percent- age	Pa- tients	Percent- age	Pa- tients	Per- cent- age	Patients	Percentage					
6/6-6/9	98	98%	28	93.33%	98	98%	29	96.67%	0.529; NS (2.213)	0.196; NS (1.293)	1.000; NS (0.000)	0.557; NS (0.587)	0.671; NS (0.425)
6/12-6/18	2	2%	2	6.67%	2	2%	1	3.33%					
6/24-6/36	0	0%	0	0%	0	0%	0	0%					
≤6/60	0	0%	0	0%	0	0%	0	0%					
Total	100	100%	30	100%	100	100%	30	100%					

Table 9: Postoperative analysis of BCVA at 6 months.

The Kruskal-Wallis test did not demonstrate any statistically significant differences among the four groups (p = 0.529). Consistently, further pairwise comparisons between individual groups also showed no evidence of statistical significance.

Postoperative BCNVA is comparable in four groups on each follow up visit (p > 0.05) (Table 10).

BCNVA	BCNVA	Superior Fold- able (Gp 1)		Superior Non- Foldable (Gp 2)		Temporal Fold- able (Gp 3)		Temporal Non- Foldable (Gp 4)		p value (Krus- kal Wallis Test)	Gp 1 vs Gp 2	Gp 1 vs Gp 3	Gp 2 vs Gp 4	Gp 3 vs Gp 4
		Pa- tients	Per- cent- age	Pa- tients	Percent- age	Pa- tients	Per- centage	Pa- tients	Percent- age					
Preopera- tive	N/6	0	0%	0	0%	0	0%	0	0%	1.000 (0.000) NS	1.000 (0.000) NS	1.000 (0.000) NS	1.000 (0.000) NS	1.000 (0.000) NS
	>N/6	100	100%	30	100%	100	100%	30	100%					
Preopera- tive day 7	N/6	87	87%	24	80%	87	87%	25	83.33%	0.751 (1.207) NS	0.343 (0.948) NS	1.000 (0.000) NS	0.741 (0.331) NS	0.611 (0.508) NS
	N/8- N/10	13	13%	6	20%	13	13%	5	16.67%					
	N/8- N/10	12	12%	5	16.67%	11	11%	4	13.33%					
Postopera- tive1 month	N/6	88	88%	25	83.33%	89	89%	26	86.67%	0.868 (0.722) NS	0.508 (0.662) NS	0.825 (0.221) NS	0.720 (0.359) NS	0.727 (0.349) NS
	N/8- N/10	12	12%	5	16.67%	11	11%	4	13.33%					
	N/8- N/10	12	12%	5	16.67%	11	11%	4	13.33%					
Postop- erative3 months	N/6	88	88%	25	83.33%	89	89%	26	86.67%	0.868 (0.722) NS	0.508 (0.662) NS	0.825 (0.221) NS	0.720 (0.359) NS	0.727 (0.349) NS
	N/8- N/10	12	12%	5	16.67%	11	11%	4	13.33%					
Postop- erative6 months	N/6	88	88%	25	83.33%	89	89%	26	86.67%	0.868 (0.722) NS	0.508 (0.662) NS	0.825 (0.221) NS	0.720 (0.359) NS	0.727 (0.349) NS
	N/8- N/10	12	12%	5	16.67%	11	11%	4	13.33%					

Table 10: Comparison of postoperative BCNVA in four groups.

The mean preoperative astigmatism was comparable among all four groups (Group 1: 0.68 ± 0.30 D, Group 2: 0.86 ± 0.58 D, Group 3: 0.77 ± 0.52 D, Group 4: 0.76 ± 0.43 D), with no statistically significant difference observed (p=0.231; NS). Pairwise intergroup comparisons at baseline were also statistically non-significant, indicating homogeneity among groups prior to surgical intervention.

On postoperative day 7, a statistically highly significant difference was noted among the groups (p=0.001; HS). Group 2 demonstrated the highest mean astigmatism (2.25 ± 0.77 D), followed by group 4 (1.57 ± 0.55 D), group 1 (1.37 ± 0.62 D), and group 3 (1.09 ± 0.44 D). Intergroup comparisons revealed highly significant differences in most comparisons, indicating greater surgically induced astigmatism in certain groups during the early postoperative period (Table 11).

	Group 1	Group 2	Group 3	Group 4	p value (F value)	GP 1 vs GP 2	GP 1 vs GP 3	GP 2 vs GP 4	GP 3 vs GP 4
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD			GP 3	GP 4	GP 4
Pre-Operative	0.68 ± 0.30D	0.86 ± 0.58D	0.77 ± 0.52D	0.76 ± 0.43D	0.231; NS (1.441)	0.223; NS	0.512; NS	0.820; NS	1.000; NS
Post-op Day7	1.37 ± 0.62D	2.25 ± 0.77D	1.09 ± 0.44D	1.57 ± 0.55D	0.001; HS (33.380)	0.001; HS	0.003; S	0.001; HS	0.001; HS
Postoperative 1 month	1.18 ± 0.42D	1.88 ± 0.56D	0.96 ± 0.37D	1.47 ± 0.33D	0.001; HS (43.510)	0.001; HS	0.001; HS	0.001; HS	0.001; HS
Postoperative 3 month	1.01 ± 0.63D	1.59 ± 0.43D	0.77 ± 0.39D	1.15 ± 0.53D	0.001; HS (20.723)	0.001; HS	0.007; S	0.006; S	0.003; S
Postoperative 6 month	0.89 ± 0.63D	1.53 ± 0.42D	0.68 ± 0.40D	1.02 ± 0.46D	0.001; HS (22.658)	0.001; HS	0.001; HS	0.001; HS	0.008; S

Table 11: Astigmatism analysis in four groups.

One month after surgery, all groups showed a further reduction in mean astigmatism; however, significant differences between the groups persisted (p = 0.001; HS). Group 2 (1.88 ± 0.56 D) exhibited the highest astigmatism, while group 3 (0.96 ± 0.37 D) recorded the lowest.

At 3 months postoperatively, a progressive decline in mean astigmatism was observed across all groups. However, statistically significant differences continued to persist (p=0.001 at 3 months). Group 2 consistently showed higher astigmatic values, while group 3 demonstrated comparatively lower and more stable readings.

By 6 months postoperatively, mean astigmatism values approached preoperative levels in most groups. The intergroup difference remained statistically significant (p = 0.001; HS). Group 3 (0.68 ± 0.40 D) showed the least mean astigmatism, while group 2 (1.53 ± 0.42 D) continued to demonstrate comparatively higher values.

Overall, although all groups exhibited an initial postoperative rise in astigmatism followed by gradual stabilization over time, significant intergroup differences were evident throughout the postoperative follow-up period, with group 2 consistently showing higher surgically induced

astigmatism and group 3 demonstrating comparatively better astigmatic stability.

Preoperatively, mean corneal astigmatism was 0.68 ± 0.30 D in superior foldable (GP1), 0.86 ± 0.58 D in superior non-foldable (GP2), 0.77 ± 0.52 D in temporal foldable (GP3), and 0.76 ± 0.43 D in temporal non-foldable (GP4).

Postoperatively, astigmatism increased in the early postoperative period in all groups, with the maximum increase observed in the superior non-foldable group (2.25 ± 0.77 D).

During follow-up, astigmatism gradually decreased in all groups, indicating progressive corneal stabilization. In group1, group 2, and group 4, the postoperative change remained statistically significant at all follow-up visits (p < 0.05).

However, in the temporal foldable group (GP3), the postoperative astigmatism was lower and returned close to preoperative values, becoming statistically non-significant at 3 months, and 6 months (Table 12).

Discussion

Cataract surgery remains the definitive management for lens opacification and is one of the most commonly performed ophthalmic procedures worldwide. Phacoemulsification with foldable IOLs has emerged as the preferred technique due to its smaller incision size, reduced surgical trauma, and faster visual rehabilitation

AST	Superior Foldable (GP 1)	Superior Non-Foldable (GP 2)	Temporal Foldable (GP 3)	Temporal Non-Foldable (GP 4)	p value in GP1 (Wilcoxon Signed)	p value in GP2 (Wilcoxon Signed)	p value in GP3 (Wilcoxon Signed)	p value in GP4 (Wilcoxon Signed)
	Mean $\pm$ SD	Mean $\pm$ SD	Mean $\pm$ SD	Mean $\pm$ SD				
Pre-Operative	0.68 $\pm$ 0.30D	0.86 $\pm$ 0.58D	0.77 $\pm$ 0.52D	0.76 $\pm$ 0.43D	---	---	---	---
Postoperative Day 7	1.37 $\pm$ 0.62D	2.25 $\pm$ 0.77D	1.09 $\pm$ 0.44D	1.57 $\pm$ 0.55D	0.001 (7.698)	0.001 (5.250)	0.001 (5.981)	0.001 (4.093)
Postoperative 1 Month	1.18 $\pm$ 0.42D	1.88 $\pm$ 0.56D	0.96 $\pm$ 0.37D	1.47 $\pm$ 0.33D	0.001 (7.748)	2.538 (0.011)	0.040 (2.084)	0.001 (4.268)
Postoperative 3 Month	1.01 $\pm$ 0.63D	1.59 $\pm$ 0.43D	0.77 $\pm$ 0.39D	1.15 $\pm$ 0.53D	0.001 (4.318)	0.001 (3.832)	0.315 (1.009)	0.006 (2.724)
Postoperative 6 Month	0.89 $\pm$ 0.63D	1.53 $\pm$ 0.42D	0.68 $\pm$ 0.40D	1.02 $\pm$ 0.46D	0.010 (2.569)	0.001 (3.889)	1.000 (1.645)	0.026 (2.230)

Table 12: Comparison of preoperative and postoperative astigmatism in four groups.

compared to conventional extracapsular and intracapsular methods while also reducing postoperative astigmatism.

In the present study, 260 patients were evaluated to compare visual and refractive outcomes following phacoemulsification using superior and temporal approaches with both foldable and non-foldable IOLs. The mean age distribution across all groups was comparable and consistent with previously reported studies by Hennig A., *et al.* [18], Tyagi R., *et al.* [19] and Nikose AS., *et al.* [8] suggesting demographic uniformity and minimizing bias in outcomes.

Preoperative UCVA was similar among all groups, with the majority of patients presenting with vision worse than 6/60. Postoperatively, a marked improvement in UCVA was observed across all groups at each follow-up interval, with most patients achieving vision between 6/6 and 6/18. However, no statistically significant difference was noted between the groups at any time point. These findings are in agreement with studies by Hennig A., *et al.* [18] which also reported comparable UCVA outcomes between foldable and rigid IOL groups. Although Wang X., *et al.* [20] demonstrated slightly better early UCVA recovery with temporal incisions, our study showed comparable long-term outcomes between both approaches.

BCVA improved significantly in all groups postoperatively, with no statistically significant intergroup differences at any follow-up interval. At 6 months, the majority of patients across all groups achieved BCVA better than 6/9, with none having BCVA worse than 6/18. These results are consistent with studies by Afsar AJ., *et al.* [21], Alam M., *et al.* [22] and Keng Q., *et al.* [23] all of which reported excellent and comparable BCVA outcomes irrespective of IOL type or incision site. This suggests that both surgical approach and IOL type provide satisfactory visual rehabilitation when standard surgical techniques are followed.

Best corrected near visual acuity (BCNVA) outcomes were also comparable across all groups, with the majority achieving N6 vision.

Postoperative astigmatism, however, demonstrated a clear pattern. The temporal foldable group showed the least mean astigmatism (0.67 D), followed by the superior foldable group (0.89 D), temporal non-foldable group (1.01 D), and superior non-foldable group (1.49 D). These findings highlight the combined advantage of temporal incision placement and foldable IOL implantation in minimizing postoperative astigmatism.

The reduced astigmatism observed with temporal incisions may be attributed to their location away from the visual axis

and reduced influence of eyelid pressure. In contrast, superior incisions are subjected to continuous upper eyelid forces, which may alter corneal curvature during healing and contribute to higher SIA. Additionally, larger incisions required for non-foldable IOL implantation, especially when sutures are used, may further increase astigmatism due to wound tension and delayed corneal remodeling.

These findings are consistent with previous studies. Wang X., *et al.* [20] and Nikose AS., *et al.* [8] reported lower postoperative astigmatism in temporal incisions (0.57 D) compared to superior incisions (0.99 D). Furthermore, Tyagi R., *et al.* [19] also reported lower astigmatism with foldable IOLs compared to rigid IOLs.

Overall, the findings of the present study indicate that while both superior and temporal approaches and both types of IOLs provide excellent visual acuity outcomes, temporal incisions combined with foldable IOL implantation offer a distinct advantage in reducing postoperative astigmatism. This contributes to improved uncorrected visual acuity and faster visual rehabilitation.

The present study has certain limitations that should be acknowledged. Firstly, the sample size in all four groups was relatively small. In our institution, phacoemulsification with foldable intraocular lens implantation is performed more frequently than with non-foldable IOLs, which resulted in a comparatively lower number of patients in group 2 and group 4. Secondly, the duration of follow-up was limited to six months. While this period is adequate for assessing short-term outcomes, evaluation of long-term effects would require extended follow-up over a longer duration.

Conclusion

Thus, we conclude that both superior and temporal approaches with foldable and non-foldable IOLs resulted in comparable UCVA and BCVA outcomes over the follow-up period.

However, a significant difference was observed in terms of postoperative astigmatism. Postoperative astigmatism was found to be comparatively lower in the temporal approach and in eyes implanted with foldable intraocular lenses. Among all groups, the temporal foldable group (Group 3) demonstrated the least surgically induced astigmatism, with values approaching preoperative levels and becoming statistically non-significant from

two months onwards.

Therefore, temporal approach phacoemulsification with foldable IOL implantation may be considered the most effective technique for achieving optimal refractive outcomes with minimal surgically induced astigmatism and excellent patient acceptance.

Conflict of Interest

None.

Funding Source

None of the authors have any financial disclosure regarding materials used in study.

Ethics Statement

The study was approved by institutional Ethics Committee and Review Board.

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