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Visual outcomes and higher-order aberrations of wavefront vs. combined wavefront aspheric myopic LASIK

ABSTRACT

Objective

We compared the efficacy, safety, refractive and visual outcomes, and aberrometry results of wavefront-guided aspheric treatment (WTA) versus wavefront-guided treatment (WT).

Methods

This prospective, contralateral, comparative study included 60 eyes of 30 patients who underwent myopic LASIK. One eye of each patient was randomized to either WTA or WT. Patients were followed up for 3 months postoperatively. Two-tailed paired t-test was used to determine statistical significance.

Results

At 3 months, 93% of eyes in the WTA group and 83% in the WT group had high-contrast uncorrected distance visual acuity (UDVA) of 20/20, while 87% in both groups achieved low-contrast UDVA of 20/40 or better. Sixty-four percent in the WTA gained 1 or more lines of low-contrast corrected distance visual acuity (CDVA) compared to 50% in the WT group. The mean sphere was 0.17D in the WTA and 0.14D in the WT ($p = 0.63$). The mean spherical equivalent was –0.04D for WTA and –0.03D for WT ($p = 0.88$). All eyes in both groups were within ±1.00D of the target emmetropia. The mean change in total higher-order aberration (HOA) was 0.07 µm in the WTA compared to 0.15 µm in the WT group ($p = 0.04$). The mean change in spherical aberration was –0.01 µm in the WTA and 0.18 µm in the WT group ($p < 0.001$). The mean change in Q value was significantly lower in the WTA (0.31) than in the WT group (0.63) ($p < 0.001$).

Conclusion

Wavefront aspheric LASIK (WTA) is a safe and effective treatment for myopic astigmatism. Refractive and visual outcomes were similar for both groups. WTA had less induction of higher-order aberration, lower spherical aberration, and better preservation of corneal asphericity (Q value). This translated to more lines of low-contrast vision gained compared to WT.

Keywords: *LASIK, Wavefront-guided, Aspheric, Spherical aberration, higher-order aberration, Corneal curvature*

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LASER-IN-SITU keratomileusis (LASIK) is a widely accepted procedure for correcting refractive errors. Initially, laser vision correction only addressed lower-order (second-order) aberrations, specifically defocus (sphere) and astigmatism (cylinder). Conventional LASIK yielded good refractive outcomes but was observed to increase higher-order aberrations (HOA).[1-6] Patients who had conventional treatment experienced starbursts, halos, and glares despite the lowering or correction of their refractive errors.[6-7] Further examination of these patients uncovered the importance of HOA; more significantly, spherical aberration (SA)[1, 7-9] in the quality of vision. Increased awareness and patient expectations led to the development of better treatment modalities to manage these aberrations.

Wavefront-guided algorithms were designed to take into consideration HOA and their effect on postoperative vision.[3, 5, 9-11] Wavefront sensors or aberrometers measure preoperative HOA. Sophisticated proprietary algorithms created customized (wavefront-guided) treatment patterns to treat lower-order (defocus and astigmatism), as well as higher-order aberrations.[4]

Despite the theoretical advantage of using wavefront-guided treatment, myopic LASIK still induced an increase in spherical aberration that affected low-contrast vision. Attention was, therefore, focused on the study of corneal asphericity, spherical aberration and its effect on vision.

The Q value is a measure of corneal asphericity. It is a measure of shape and how it affects bending of light. When light goes through an optical medium or lens surface, the shape of the optical medium dictates where the peripheral and central rays of light will eventually focus behind the lens. Negative Q values connote prolateness and positive Q values connote oblateness. The normal unoperated cornea is prolate with negative asphericity and negative Q value. Myopic LASIK typically converts a prolate cornea into an oblate cornea; therefore, Q values likewise increase.[8, 12]

Aspheric or optimized software was developed and compared to conventional and wavefront-guided treatments to determine if it would improve low-contrast vision vis-à-vis conventional and wavefront-guided algorithms. Ang et al. found that using an aspheric algorithm was more effective than conventional algorithm in reducing induced spherical aberration and maintaining corneal asphericity after myopic LASIK. They also reported that eyes treated with an aspheric algorithm significantly gained more lines of low-contrast vision.[8]

Wavefront-guided treatments were designed to minimize preoperative HOA and aspheric treatment to minimize induction of postoperative spherical aberration without affecting or reducing other HOA. The synergy of combining a wavefront-guided algorithm with an aspheric treatment overlay theoretically maximizes the HOA-lowering effect of both treatment algorithms. This study determined if adding an aspheric overlay in a wavefront-guided treatment (WTA) would result in a significant improvement in refractive and visual outcomes and postoperative HOA measurements compared to wavefront-guided treatment (WT) alone.

METHODOLOGY

This is a prospective, randomized, subject-masked, contralateral, comparative clinical study of 60 eyes seen in a single center from March to September 2009.

The research protocol followed the guidelines of the declaration of Helsinki and was approved by the local ethics review board. All patients were fully informed of the nature and details of the procedure. The scope of the study, including all the risks and benefits involved, was explained. Informed consent was secured in writing from all patients prior to the procedure.

Contact-lens wear was discontinued for at least 3 weeks for rigid gas permeable lenses and 1 week for soft contact lenses before the preoperative evaluation. All patients underwent refractive screening that included history taking, high (HC) and logMAR low-contrast (LC) corrected and uncorrected visual-acuity measurements using the Precision Vision Visual Acuity Charts–ZyQV Charts (Precision Vision Inc., La Salle, IL, USA), manifest and cycloplegic refraction, dim-light pupil size, slitlamp examination, intraocular-pressure check, ultrasonic pachymetry, Schirmer's test, corneal topography using Orbscan IIz version 3.14 (Technolas Perfect Vision, Munich, Germany), undilated and dilated wavefront aberrometry measurements using the Zywave II Wavefront Aberrometer version 5.20 (Technolas Perfect Vision, Munich, Germany), and dilated-fundus examination.

Inclusion criteria were as follows: patients 18 years old and above who had up to –10.00D of absolute spherical myopia, with up to –4.00D of refractive astigmatism in both eyes, with spherical equivalent not exceeding –12.00D and had stable refraction for the past 12 months. High-contrast best-corrected distance visual acuity was correctable to at least 0.1 (20/25) in all eyes and did not differ by more than 1 line between eyes. Contact-lens wearers had 2 central keratometry readings and 2 manifest subjective refractions done 1 week apart. They were included if the refraction and keratometry values taken on 2 separate occasions did not differ by more than 0.50D.

Exclusion criteria were as follows: presence of anterior-segment pathology including dry-eye syndrome, cataract, and residual, recurrent or active ocular disease that would interfere with best-corrected distance visual acuity, previous intraocular or corneal surgery, history of herpes simplex or herpes zoster keratitis, unstable keratometry readings with irregular mires, glaucoma, risk for angle closure, retinal pathology, signs of keratoconus, ocular muscle disorder affecting fixation, connective tissue and immunologic disease, pregnancy, lactation, use of steroids and immunomodulating drugs, and hypersensitivity to medications that will be used in the study. Subjects were also excluded if the preoperative corneal-topography assessment indicated that one or both eyes were not suitable for treatment based on the computer-simulated treatment plan, and if the combination of their baseline corneal thickness and the planned preoperative parameters for LASIK would result in less than 250 microns of remaining posterior corneal thickness below the flap postoperatively. Eyes whose baseline manifest subjective refraction exhibited a difference of ±0.75D or a difference of ±0.50D or greater in cylinder power, or a difference in cylinder axis of more than 15 degrees compared to the baseline cycloplegic subjective refraction were, likewise, excluded from the study.

Surgical procedure

All laser treatments targeted emmetropia. A randomization table was used for each patient to determine which eye would undergo WTA and WT. The surgery was done on both eyes on the same day by a single surgeon (RTA). The right eye was treated first, followed by the left. The patients were blinded as to which eye would receive WTA or WT.

Wavefront treatments (WT) were computed using Zyoptix PT Calculator ver. 1.1 with Advanced Nomogram ver. 2.7 (Technolas Perfect Vision, Munich, Germany). Wavefront aspheric treatments (WTA) were computed using Zyoptix PTA Calculator ver. 1.3 (Technolas Perfect Vision, Munich, Germany) with no advanced nomogram.

Aseptic technique was observed throughout the surgical procedure. Povidone-iodine scrub solution (Betadine, Purdue Pharma, Stamford, CT, USA) was used to prepare the eye for surgery followed by application of sterile drapes and placement of the lid speculum. Proparacaine (Alcaine, Alcon Laboratories, Dallas, TX, USA) was instilled to maintain anesthesia during the procedure. A superior-hinged flap was created using a Zyoptix XP 120 µm microkeratome (Technolas Perfect Vision, Munich, Germany). Laser ablation was performed using the Technolas 217z100 excimer laser (Technolas Perfect Vision, Munich, Germany). Postoperative medications given were levofloxacin (Oftaquix, Santen, Osaka, Japan) and prednisolone acetate (Pred Forte, Allergan, Irvine, CA, USA) 4 times a day for at least 2 weeks. Artificial lubricants were also prescribed for at least a month to address dry-eye symptoms.

Postoperative follow-up

The patients were followed up for 3 months postoperatively. High- and low-contrast uncorrected distance visual acuity (UDVA), best-corrected distance visual acuity (CDVA), and subjective refraction were measured during each visit. Aberrometry readings were performed at 1 and 3 months follow-up to measure HOA.

Data analysis

Means and standard deviations of the results were computed. Visual acuity (VA) was expressed in the logarithm of minimum angle of resolution (Log MAR) scale for the analysis. Statistical analysis of the collected data was performed using the Open Epi statistical software. Paired student's t-test, two-tailed, was used with the significance level set at $p < 0.05$.

RESULTS

Thirty patients (60 eyes), 77 percent females, were enrolled in and completed the study. The mean age was 31.8 ± 7.65 years (range, 18 to 49) (Table 1).

The mean preoperative sphere was –4.26 in the WTA and –4.43 in the WT groups. The mean preoperative cylinder was –0.67 in the WTA and –0.68 in the WT groups. The mean spherical equivalent was –4.60 D and –4.77 D in the WTA and WT groups respectively (Table 1).

Preoperatively, the mean high-contrast UDVA in the WTA and WT groups was counting fingers. Mean high-contrast CDVA was 20/20 while mean low-contrast CDVA was 20/32 in both groups.

One day postoperatively, 57% of eyes in the WTA group had VA of 20/20 or better compared to 47% in the WT group. At 3 months, 93% of eyes in the WTA group had high-contrast UDVA of 20/20 compared to 83% in the WT group. High-contrast UDVA was 20/25

Table 1. **Demographic characteristics of the study population.**

	Wavefront-Guided Aspheric (WTA) Eyes n = 30	Wavefront-Guided (WT) Eyes n = 30
Male to Female Ratio	1:3	
Mean Age	31.8 ± 7.65 years	
Range	18 to 49 years	
Mean Sphere	–4.26 ± 1.89 D	–4.43 ± 1.80 D
Range	–0.75 to –8.00 D	–1.00 to –8.25 D
Mean Cylinder	–0.67 ± 0.62 D	–0.68 ± 0.62 D
Range	0 to –2.25 D	0 to –2.25 D
Mean Spherical Equivalent	–4.60 ± 1.91 D	–4.77 ± 1.82 D
Range	–1.50 to –8.50 D	–1.50 to –8.50 D

or better in all eyes in both groups at 3 months (Figure 1).

One day postoperatively, 97% of eyes in the WTA and 87% in the WT groups had high-contrast CDVA of 20/20 or better. Three months postoperatively, 97% of eyes in the WTA and 100% in the WT groups had VA of 20/20 or better. High-contrast CDVA was 20/25 or better in all eyes 3 months after surgery (Figure 2).

One week postoperatively, 70% of eyes in the WTA and 80% in the WT groups had VA of 20/40 or better, while 17% in both groups had low-contrast UDVA of 20/25. Three months postoperatively, 87% in both groups had low-contrast UDVA of 20/40 or better while 20% in the WTA and 27% in the WT groups had low-contrast UDVA of 20/25 or better (Figure 3). Mean low-contrast UDVA was 20/32 for both groups at 3 months.

One day postoperatively, 80% of eyes in the WTA and 67% in the WT groups had VA of 20/40 or better, while 13% in the WTA and 20% in the WT groups had low-contrast CDVA of 20/25. At 3 months, 93% in both groups had VA of 20/40, while 50% in the WTA and 53% in the WT groups had low-contrast CDVA of 20/25 or better (Figure 4). Mean low-contrast CDVA was 20/32 in both groups at 3 months.

Gain or loss of lines

At 3 months, 13% of WTA and 10% of WT eyes gained 2 or more lines of high-contrast CDVA. One eye (3%) in the WTA and none in the WT group lost 2 lines of CDVA (Figure 5).

Three months postoperatively, 37% of eyes in the WTA and 27% in the WT groups gained 2 or more lines of low-contrast CDVA. No eye in the WTA and 7% in the WT groups lost 2 lines of low-contrast CDVA. However, one eye (3%) in the WTA group lost 3 lines of low-contrast CDVA (Figure 6).

Refractive outcome

Preoperatively, the mean sphere was –4.26D in the WTA and –4.43D in the WT groups, which improved to 0.17D and 0.14D, respectively at 3 months (Table 2). There was no statistically significant difference between the two groups at 3 months ($p = 0.63$).

The mean cylinder was –0.68D in both groups preoperatively, which decreased to –0.42D in the WTA and –0.35D in the WT groups at 3 months postoperatively (Table 3). The difference was not statistically significant ($p = 0.25$).

Preoperatively, the mean spherical equivalent (SE) was –4.60D in the WTA and –4.43D in the WT groups. The mean SE at 3 months improved to –0.01D in the WTA and 0.14D in the WT groups (Table 4). The difference was not statistically significant ($p = 0.88$).

Refractive predictability

At 3 months, all eyes in both groups were within ± 1.00D of the target emmetropia (Table 5). In the WTA group, 97% were within ± 0.50D and 63% were within ± 0.25D of the target emmetropia. In the WT group, 100% were within ± 0.50D and 83% were within ± 0.25D of the target emmetropia.

Table 2. **Comparison of mean sphere between WTA and WT.**

	WTA		WT		p
	Mean (D)	Range (D)	Mean (D)	Range (D)	
Pre-op	–4.26 ± 1.89	–0.75 to –8.00	–4.43 ± 1.80	–1.00 to –8.25	
1 day	0.18 ± 0.26	–0.25 to 0.75	0.32 ± 0.33	–0.25 to 1.00	
1 week	0.21 ± 0.25	0.00 to 0.75	0.26 ± 0.29	–0.25 to 0.75	
1 month	0.20 ± 0.24	0.00 to 0.75	0.20 ± 0.23	0.00 to 0.75	0.99
3 months	0.17 ± 0.23	–0.25 to 0.75	0.14 ± 0.24	–0.25 to 0.75	0.63

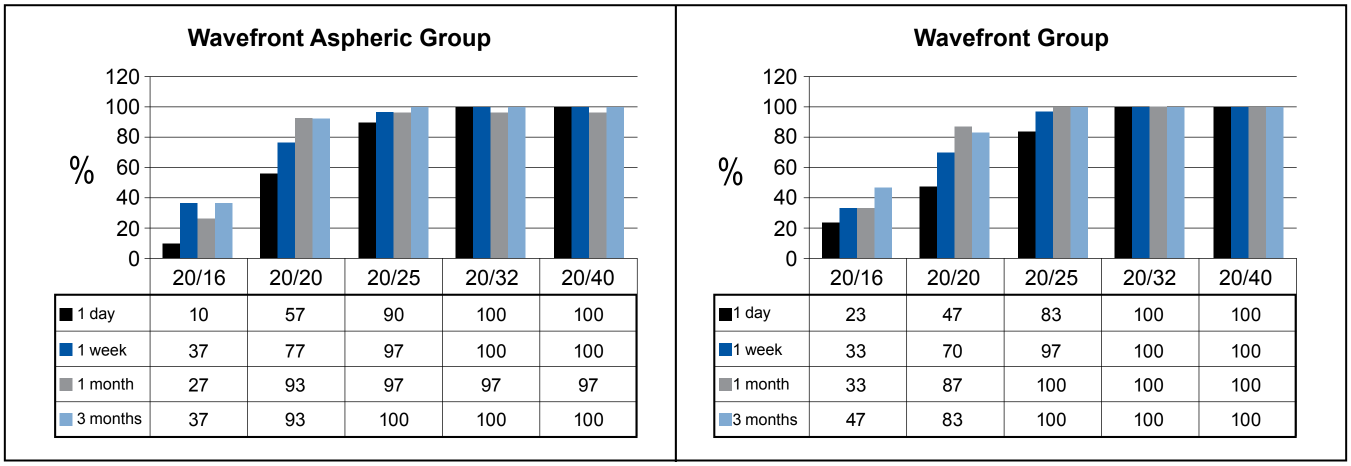
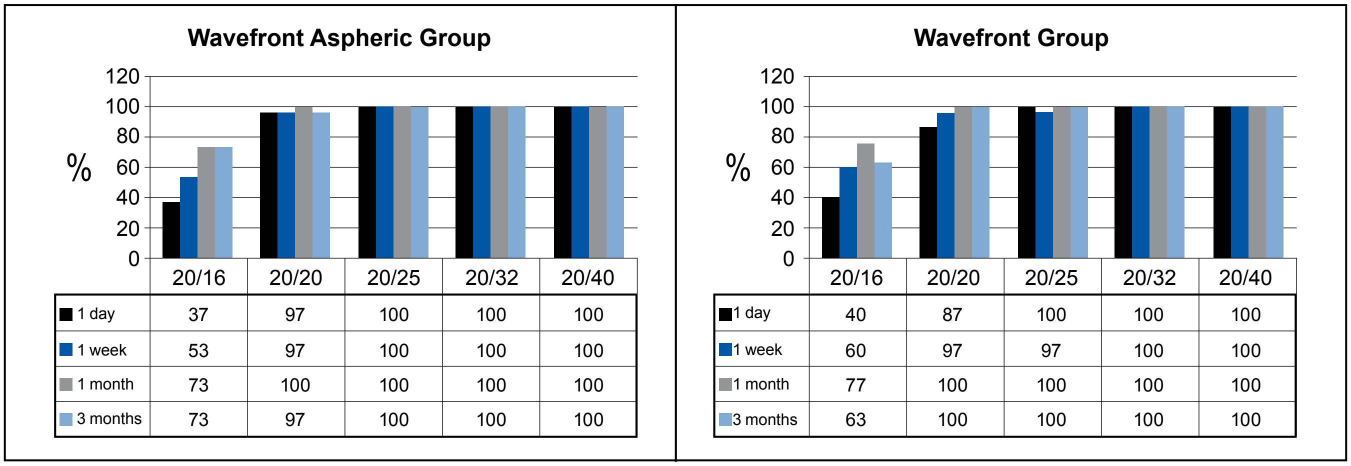


Figure 1. Postoperative high-contrast uncorrected distance visual acuity.



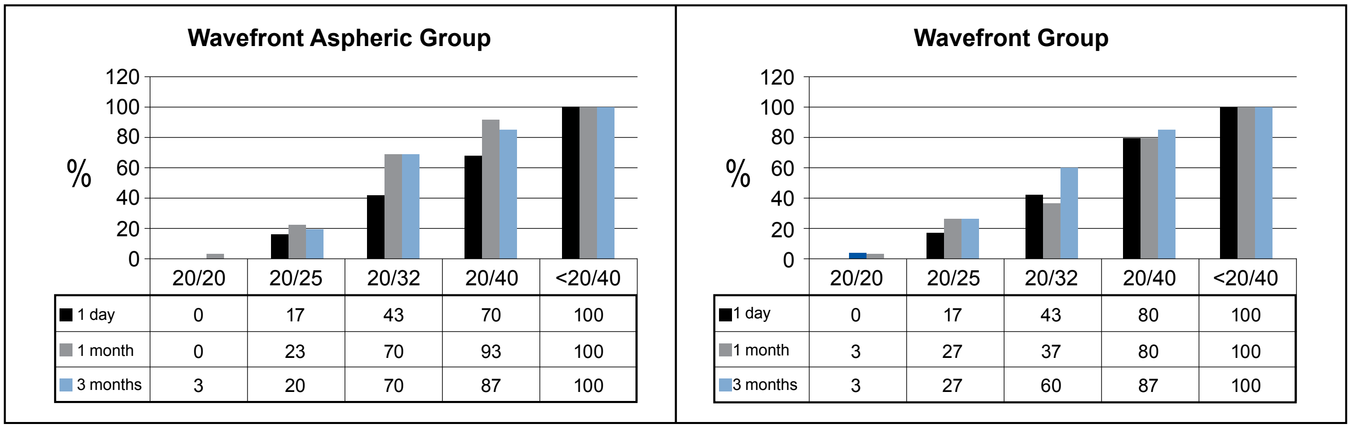
Wavefront Aspheric Group

	20/16	20/20	20/25	20/32	20/40
■ 1 day	37	97	100	100	100
■ 1 week	53	97	100	100	100
■ 1 month	73	100	100	100	100
■ 3 months	73	97	100	100	100

Wavefront Group

	20/16	20/20	20/25	20/32	20/40
■ 1 day	40	87	100	100	100
■ 1 week	60	97	97	100	100
■ 1 month	77	100	100	100	100
■ 3 months	63	100	100	100	100

Figure 2. Postoperative high-contrast corrected distance visual acuity.



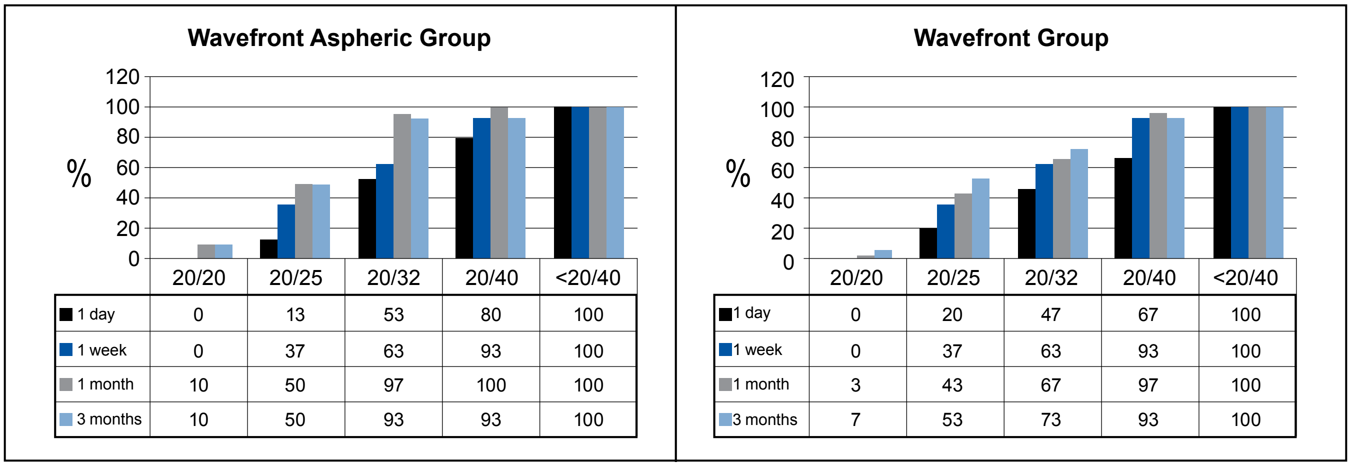
Wavefront Aspheric Group

	20/20	20/25	20/32	20/40	<20/40
■ 1 day	0	17	43	70	100
■ 1 month	0	23	70	93	100
■ 3 months	3	20	70	87	100

Wavefront Group

	20/20	20/25	20/32	20/40	<20/40
■ 1 day	0	17	43	80	100
■ 1 month	3	27	37	80	100
■ 3 months	3	27	60	87	100

Figure 3. Postoperative low-contrast uncorrected distance visual acuity.



Wavefront Aspheric Group

	20/20	20/25	20/32	20/40	<20/40
■ 1 day	0	13	53	80	100
■ 1 week	0	37	63	93	100
■ 1 month	10	50	97	100	100
■ 3 months	10	50	93	93	100

Wavefront Group

	20/20	20/25	20/32	20/40	<20/40
■ 1 day	0	20	47	67	100
■ 1 week	0	37	63	93	100
■ 1 month	3	43	67	97	100
■ 3 months	7	53	73	93	100

Figure 4. Postoperative low-contrast corrected distance visual acuity.

Higher-order aberrations

Preoperatively, the mean HOA was 0.38 µm in the WTA and 0.37 µm in the WT groups. The mean vertical and horizontal coma, vertical and horizontal trefoil were also measured in both groups. The measured mean spherical aberration was –0.13 µm and –0.14 µm in the WTA and WT groups, respectively.

Three months postoperatively, there was no statistical difference in the mean vertical and horizontal coma, and vertical and horizontal trefoil between the two groups.

The mean total HOA was 0.45 μm in the WTA and 0.52 μm in the WT groups, while the mean spherical aberration was 0.12 μm and 0.32 μm, respectively. The difference in mean total HOA ($p = 0.03$) and mean spherical aberration ($p < 0.001$) was statistically significant (Table 6).

The mean change in total HOA ($p = 0.04$) and spherical aberration ($p < 0.001$) at 3 months were significantly higher in the WT group compared to the WTA group. The mean change in vertical and horizontal coma, vertical and horizontal trefoil were not significantly different between the groups (Table 7).

Corneal curvature

The mean Q value was –0.19 in the WTA and –0.18 in the WT groups preoperatively, and 0.14 and 0.46 respectively at 3 months (Table 8). There was a lesser increase in mean Q value in the WTA group (0.31) compared to the WT group (0.64), the difference of which was statistically significant ($p < 0.001$).

DISCUSSION

Total higher-order and spherical aberrations often increase after LASIK, resulting in decreased visual performance and a degraded retinal image. Several studies[1,6-7, 10, 13-14] have reported that wavefront-guided algorithms induce less increase in HOAs but are not highly effective for spherical aberrations, causing decreased visual sharpness and problems with nighttime vision manifested as glare and halos. Aspheric algorithms, on the other hand, aim to maintain the preoperative asphericity of the anterior corneal surface leading to decreased induction of spherical aberration postoperatively, but it does not address the preoperative HOA.[8] Therefore, a single algorithm aimed at reducing preoperative higher-order aberrations and minimizing the induction of spherical aberration is ideal in optimizing postoperative visual performance.

Table 3. **Comparison of mean cylinder between WTA and WT.**

	WTA				WT				*p*
	Mean	Min	Max	SD	Mean	Min	Max	SD	
Pre-op	–0.68	0	–2.50	0.61	–0.68	0	–2.25	0.62	
1 day	–0.46	0	–1.25	0.31	–0.33	0	–0.75	0.33	
1 week	–0.45	0	–1.25	0.31	–0.32	0	–1.00	0.35	
1 month	–0.42	0	–1.25	0.34	–0.37	0	–0.75	0.23	0.46
3 months	–0.42	0	–1.25	0.31	–0.35	0	–1.00	0.27	0.25

Table 4. **Mean spherical equivalent between WTA and WT.**

	WTA				WT				*p*
	Mean	Min	Max	SD	Mean	Min	Max	SD	
Pre-op	–4.60	–1.50	–8.50	1.91	–4.43	–1.00	–8.25	1.80	
1 day	–0.05	–0.63	–0.50	0.31	0.10	–0.63	0.88	0.40	
1 week	–0.03	–0.63	–0.50	0.25	0.08	–0.50	0.63	0.31	
1 month	–0.01	–0.63	–0.63	0.30	0.02	–0.38	0.50	0.25	0.88
3 months	–0.04	–0.63	–0.50	0.28	–0.03	–0.50	0.50	0.26	0.88

In our study, we used our current wavefront algorithm (WT) as benchmark to determine if an additional aspheric overlay (WTA) would provide measurable indices in demonstrating improvement in visual, refractive, wavefront-aberration, and Q-value outcomes.

The high-contrast UDVA and CDVA, and low-contrast UDVA and CDVA were comparable in both groups. Refractive outcomes in terms of sphere and spherical equivalent were, likewise, similar between the groups. Since treatment calculations in the WT group were done with an advanced nomogram, predictability was higher with more than 75% of the eyes in this group within ± 0.25D

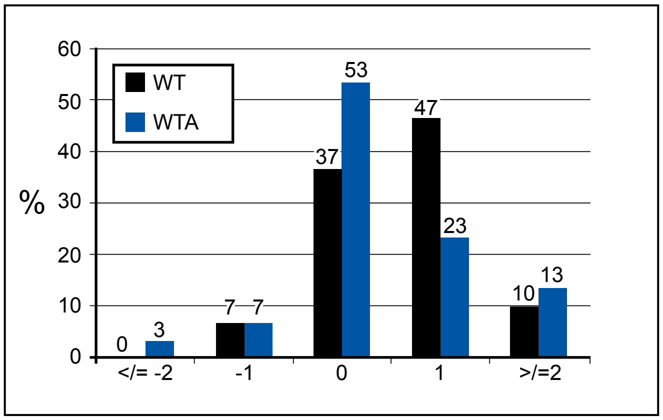


Figure 5. Gain or loss of lines of high-contrast corrected distance visual acuity.

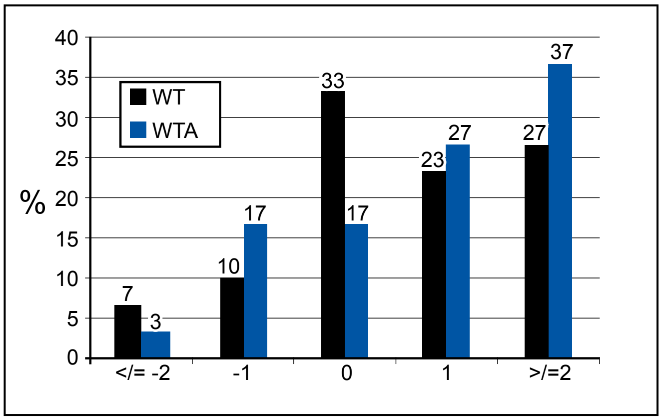


Figure 6. Gain or loss of lines of low-contrast corrected distance visual acuity.

and all eyes within ± 0.50D of targeted emmetropia. The nomogram-adjusted treatment calculator was not yet available for the WTA during this study; yet, two-thirds of the eyes in the WTA were within ± 0.25D and almost all were within ± 0.50D of emmetropia.

This study demonstrated that the mean change in higher-order and spherical aberrations was lower in the WTA group. Even if both the WTA and WT showed change in corneal shape towards positive asphericity, the mean change in Q value was significantly lower in the WTA group. Clinically, the eyes in the WTA group gained more lines of low-contrast vision. (Figure 6) This clearly suggests the significance of reducing induction of spherical aberration and total HOA, and preserving corneal asphericity by inducing less increase in Q value. [1, 8, 15-16]

One eye in the WTA group lost 3 lines in low-contrast vision. On review of the aberration profile, this patient had a pronounced postoperative increase in coma and higher-order aberration despite a low mean change in spherical aberration and a negative Q value. It was possible that a subclinical decentered ablation occurred that resulted in significant coma in this patient. Coma can be thought of as an off-axis spherical aberration,[8] hence its effect on high- and low-contrast vision.

In summary, wavefront aspheric LASIK (WTA) is a safe and effective treatment for myopic astigmatism. Refractive and visual outcomes were comparable between the WTA and WT groups. Wavefront aspheric treatments induced less spherical and higher-order aberrations. Corneal asphericity was, likewise, better preserved with this algorithm. This translated to more lines of low-contrast vision gained in the WTA group compared to wavefront treatment (WT) alone. Our findings are consistent with those of other studies that demonstrate the clinical significance of adding an aspheric profile to a refractive treatment resulting in the reduction of induced spherical aberration and total HOA, and preservation of preoperative corneal asphericity (Q value).[3, 8, 17]

Our results showed that treating asphericity can improve results of wavefront-guided LASIK. We recommend that another comparative study be undertaken between

Table 5. **Refractive predictability.**

Post-op	WTA (Percent of eyes)			WT (Percent of eyes)		
	± 1.00D	± 0.50D	± 0.25D	± 1.00D	± 0.50D	± 0.25D
1 day	100	96.67	60.00	100.00	83.33	46.67
1 week	100	96.67	70.00	100.00	96.67	66.67
1 month	100	96.67	70.00	100.00	100.00	80.00
3 months	100	96.67	63.33	100.00	100.00	83.33

Table 6. **Higher-order aberrations (HOA) at 3 months.**

Higher Order Aberration	WTA		WT		*p*
	Pre-operative	3 Months Mean	Pre-operative	3 Months Mean	
Total HOA	0.38	0.45 ± 0.20	0.37	0.52 ± 0.17	**0.03**
Vertical coma	–0.01	0.10 ± 0.24	–0.01	0.07 ± 0.26	0.43
Horizontal coma	–0.04	–0.02 ± 0.21	–0.10	–0.10 ± 0.19	0.18
Vertical trefoil	0.04	–0.06 ± 0.13	0.03	–0.01 ± 0.12	0.08
Horizontal trefoil	0.04	0.01 ± 0.15	–0.03	0.01 ± 0.11	0.92
Spherical aberration	–0.13	0.12 ± 0.16	–0.14	0.32 ± 0.16	**< 0.001**

Table 7. **Change in higher-order aberrations (preop to 3 months).**

Change in	WTA	WT	*p*
Total HOA	0.07	0.15	**0.04**
Vertical coma	0.11	0.08	0.54
Horizontal coma	0.02	0.001	0.82
Vertical trefoil	–0.10	–0.04	0.09
Horizontal trefoil	–0.04	0.04	0.21
Spherical aberration	–0.01	0.18	**< 0.001**

Table 8. **Q values analysis.**

	WTA		WT	
	Range	Mean	Range	Mean
Preoperative	–0.53 to 0.07	–0.19 ± 0.12	–0.37 to 0.24	–0.18 ± 0.13
1 month postoperative	–0.34 to 0.74	0.16 ± 0.28	0.00 to 1.55	0.48 ± 0.34
3 months postoperative	–0.17 to 0.69	0.14 ± 0.22	–0.03 to 1.23	0.46 ± 0.33
Change in Q value *p* < 0.001	0.31		0.64	

a conventional (non-wavefront) aspheric and wavefront aspheric algorithm to determine if adding a wavefront treatment component to conventional aspheric LASIK treatment can also improve outcomes and determine if a combined wavefront aspheric algorithm is the best that can be offered to patients.

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