During the past decade, the field of refractive surgery has been flooded with dramatic advances introduced by new technologies. Aside from new applications of the femtosecond laser, further improvements were achieved with the development of new excimer laser platforms with higher repetition rates, faster eye trackers, and customized ablation profiles. Along with this rapid development, the primary goal of refractive surgery has evolved and today aims to provide “super vision” in terms of visual performance.

The quest for “super vision” has generated a surge of interest, leading to the development of new algorithms of treatment and numerous technological improvements in the newer generations of excimer lasers. A large number of studies comparing different ablation profiles and different excimer laser platforms have been published. However, has an ideal algorithm of treatment emerged from these studies? Does one ablation profile clearly demonstrate superiority compared to the other in regards to visual acuity, contrast sensitivity, or night symptoms?

After describing the technical properties of the various treatment algorithms using wavefront technology, we attempted to provide an overview of the clinical results available among several comparative studies. The factors tending to limit the success of these new procedures were also discussed along with future perspectives in the field. Studies reporting results of such profiles for retreatments, highly aberrated eyes, keratoconus, or transplant as well as results of topography-guided treatments were not included in this review.

TECHNICAL CONSIDERATIONS OF ABLATION PROFILES

The technical aspects of excimer laser ablation have evolved considerably since the introduction of the formula for standard
sphere-cylindrical correction described by Munnerlyn in 1988. Over the years, and with the surge of interest generated by wavefront technology, advanced laser treatment algorithms based on different concepts have been developed, aiming to correct not only lower but also higher order wavefront aberration errors.

**WAVEFRONT-GUIDED TREATMENT REQUIREMENTS**

Towards the end of the past decade, a new era began with the introduction of ablation profiles guided by the wavefront map to sculpt the cornea in a way to correct preexisting aberrations and reduce surgically induced aberrations. To achieve the precision required for this profile, advancements in excimer laser technology were needed.

The broad beam cannot treat small irregularities in the cornea and most current devices use flying-spot technology, in which smaller beams (0.5 to 1.0 mm) are used for better and more accurate results in custom ablations and the correction of irregular astigmatism. Spot sizes <1 mm are required to adequately correct up to the fourth order terms whereas 0.6-mm beams are needed to treat up to the sixth order terms. Some devices have a variable spot size (eg, VISX S4; Abbott Medical Optics Inc, Santa Ana, California).

The shape of the beam is also important to produce a smoother surface, which is best achieved with an optimized spot overlap. The energy is delivered in a Gaussian profile (greater energy density in the center of the beam than the periphery) with the Allegretto Wave Eye-Q laser (Alcon Laboratories Inc, Ft Worth, Texas), MEL 80 (Carl Zeiss Meditec AG, Jena, Germany), and NIDEK NAVEX (NIDEK Co Ltd, Gamagori, Japan).

The flying-spot laser must be delivered precisely for an accurate wavefront correction and requires high-speed eye-tracking systems because of the smaller spot size and risk of individual pulse decentration and misplacement compared to broad-beam lasers. Centration needs to be accurate, as minimal misalignment or cyclotorsion that would normally cause only a small undercorrection in the spherical-cylindrical profile can induce a completely different aberration pattern. Theoretical modeling indicates that a decentration >0.10 mm can induce rather than reduce aberrations during myopic wavefront-guided treatments.

The repetition rate of laser pulses is another feature that varies among excimer lasers. Repetition rate correlates directly with treatment time. Longer periods cause drying of the corneal stroma and loss of fixation, which are unacceptable with customized profiles. In the first broad-beam lasers, the repetition rate was low (6 to 10 Hz). With scanning-spot technology, the rate needed to increase; otherwise, treatment times would be longer because more pulses would be needed for the same ablation.

The scanning-spot frequency must not exceed a rate that can be followed by the tracking system. In addition, excessive thermal damage in adjacent tissue can occur with repetition rates higher than 60 Hz. Modern devices, such as the Amaris excimer laser (SCHWIND eye-tech-solutions GmbH & Co KG, Kleinostheim, Germany), use higher repetition rates up to 500 Hz for faster treatments with scanning spots. In these devices, a repetition rate in a determined locale does not exceed 40 Hz because the pulses are being applied sequentially in different locations of the cornea to prevent thermal damage.

**WAVEFRONT-OPTIMIZED PROFILE**

Controversy remains concerning the proper definition of the optimal ablation profile. Artal et al found that eyes with smaller wavefront aberrations did not achieve the best visual quality. In 2004, Mrochen et al designed an optimized aspheric profile to compensate only for the spherical aberration induced with the conventional treatment, preserving the preexisting optical aberration pattern of the eye. Since then, this algorithm of treatment has been introduced in several modern excimer laser platforms and is in theory less dependent on technical aspects that are critical in wavefront-guided treatment. This profile has been developed considering the loss in ablation efficacy due to the angle of incidence of the excimer laser pulses in the midperiphery (ie, the cosine effect, leading to an oval beam of reduced energy on the peripherally sloping cornea), which can lead to a decrease in the intended ablation depth in this region and an increase in spherical aberration. The optimized profiles compensate for this effect by increasing the pulse energy in the periphery.

**CUSTOM-Q FACTOR PROFILE**

Based on the concept that an ideal asphericity of the cornea could lead to a better visual performance, the “Q-factor adjusted” profile was developed to manipulate the asphericity by selecting the desired target of Q-value. Based on an aspheric eye model, Manns et al suggested that a minimum of spherical aberration would be obtained at a target Q-factor of approximately −0.4. Some excimer laser platforms are equipped with this profile such as the Allegretto Wave Eye-Q laser with the adjustable “Q software mode,” allowing the surgeon to target the Q-value independently from the preexisting spherical aberration and the NAVEX system with the “Optimized Prolate Ablation (OPA).” The OPA profile uses both corneal topography and ocular...
aberrometry to either maintain the natural corneal shape of the cornea after surgery or to target a specific corneal asphericity to improve the visual quality. The MEL 80 platform is equipped with the CRS-MASTER Laser Blended Vision module, which allows manipulation of the corneal asphericity to increase the depth of focus to overcome presbyopia. This module has been used to create a non-linear aspheric ablation to provide micro-monovision.

**CONVENTIONAL TREATMENT AND DEVELOPMENT OF CUSTOMIZED ABLATION PROFILES**

The main complaints reported by patients after conventional excimer laser refractive surgery are blurred vision under low light conditions, halos, and glare, which lead to decreased visual quality. These complaints could occur despite achieving 20/20 visual acuity on the Snellen chart and are believed to be due to the surgically induced increase in high order aberrations (HOAs) after laser treatment. By reshaping the cornea, the lasers modify the curvature and asphericity in a way that induces an increase in HOAs, especially spherical aberration, due to the optical effect of the transition zone between the treated and untreated cornea. The amount of induced optical aberrations is correlated with the level of attempted refractive correction. It is well known that the effects of significant HOAs degrade the quality of the optical image on the fovea. Although some controversy exists, it has been suggested that the correction of HOAs could lead to an improvement in contrast sensitivity and visual acuity. Therefore, the introduction of a customized correction based on the wavefront pattern of the eye was promising to overcome the main issues found in the conventional treatment.

**OVERVIEW OF THE CLINICAL RESULTS**

Over the past 10 years, a large number of studies comparing the different treatment algorithms and newer excimer laser platforms have been published. Despite efforts to show the superiority of wavefront-guided correction over the standard treatment, or a customized profile over another, it remains unclear whether an ablation profile has demonstrated its superiority over another in terms of visual performance and patient satisfaction.

For clarity, and despite the lack of standardization concerning patient selection and treatment parameters surrounding the majority of these studies, we attempted to summarize the main results reported in the literature using the different available wavefront ablation profiles (wavefront-guided, wavefront-optimized, and custom-Q) in virgin healthy eyes.

Potential advantages of using these ablation profiles in highly aberrated eyes such as retreatment for decentered ablation, small optical zone, irregular astigmatism, keratoconus, or transplant are not discussed in this review.

**INTRODUCTION OF WAVEFRONT ABLATION PROFILES**

**Wavefront-guided Treatment.** To avoid induction and reduce preexisting aberrations of the eye, the wavefront-guided profile was developed. The first results reported by Seiler et al in 2000 after performing wavefront-guided LASIK on 35 eyes were encouraging. After 3 months, 93.5% of eyes had uncorrected distance visual acuity (UDVA) of 20/20 or better, and supernormal vision, defined as 20/10 or better, was achieved in 16%. Postoperative HOAs decreased in 22.5% of eyes. However, optical aberrations increased on average by a factor 1.44 with a 5-mm pupil. More recently, studies using different wavefront-guided platforms have supported these primary results, reporting improvements in visual acuity and contrast sensitivity postoperatively.

Although this ablation profile was developed with the goal of avoiding both induction of optical aberrations and reduction of preexisting aberrations, recent studies reported the limitations of such customized treatments. Bottos et al retrospectively analyzed 177 myopic eyes and 32 hyperopic eyes that underwent wavefront-guided LASIK for correction ranging from −9.87 to +6.25 diopters (D). They reported a high correlation between the amount of preoperative refractive error and asphericity changes ($r^2=0.81, P<.001$) and induced corneal spherical aberrations ($r^2=0.34, P<.001$) and thus concluded that changes depended on the magnitude of the refractive correction. Additionally, they highlighted the tendency for the postoperative Q-value and spherical aberration to be more positive after myopic ablation and more negative after hyperopic ablation. Keir et al reported similar results in a prospective study analyzing the impact of hyperopic wavefront-guided LASIK on HOAs and contrast sensitivity. A significant change was noted in postoperative spherical aberration, which had a reverse sign (became negative) and a high correlation was found between low contrast visual acuity and induced spherical aberration ($r^2=0.62, P<.001$).

With the surge of interest generated by the wavefront-guided treatment, the need to improve outcomes to meet expectations led the current generation of lasers to undergo many technological improvements over the past 10 years. Following the company-driven technological developments, several studies comparing different wavefront-guided laser platforms have
been published despite the bias introduced such as the familiarization to the use of a new platform and the need for nomogram adjustment that is surgeon-dependent. Despite the introduction of different technological advancements in all platforms, superiority of one system over another has yet to be established in the peer-reviewed literature.24-26

Wavefront-optimized Treatment. Good visual outcomes have also been reported with the wavefront-optimized profile. George et al.27 using the Allegretto Wave Eye-Q laser, found that 92% of myopes and 63% of hyperopes achieved UDVA of 20/20 after 3 months, and no statistically significant surgically induced spherical aberration was noted among myopic eyes. Using the AMARIS platform, Arbelaez et al28 found similar results, with 84% of 50 myopic eyes achieving UDVA of 20/20 or better and 40% achieving UDVA of 20/16 or better after 6 months. No significant changes in aberration metrics were found postoperatively. Vonthongsri et al29 also reported good results after myopic treatment using the optimized aspheric treatment zone (OATz) profile, which is available with the NIDEK NAVEX system. In their study, 94.2% of eyes were within 0.50 D of the intended refraction and 75% of eyes achieved UDVA of 20/20 or better after a mean follow-up of 3 months.

RESULTS OF COMPARATIVE STUDIES BETWEEN CONVENTIONAL AND WAVEFRONT PROFILES

Conventional vs Wavefront-guided Treatment. Numerous studies published in the literature have failed to demonstrate a clear advantage of wavefront-guided over conventional treatment for low to moderate myopia and myopic astigmatism.30,31 In a contralateral study comparing 10 eyes treated with conventional LASIK and 10 eyes with wavefront-guided LASIK, Phusitphoykai et al30 did not find any statistically significant differences regarding visual outcomes and optical aberrations postoperatively. More recently, Dougherty and Bains,31 in a series of 290 eyes, compared the results of conventional LASIK using the NIDEK EC-5000 (NIDEK Co Ltd, Gamagori, Japan) with those obtained after using 2 different wavefront-guided laser platforms, the VISX S4 CustomVue (VISX, Santa Clara, California) and CustomCornea (Alcon Laboratories Inc). No statistically significant differences were observed regarding safety, efficacy, or predictability among groups.

Other studies concluded that wavefront-guided ablation induces fewer aberrations than conventional treatment, but still increases total HOAs.32,33 Kim et al.32 in a contralateral eye comparative study including 24 patients treated with LASIK using the Technolas 217z excimer laser (Bausch & Lomb Surgical, Rochester, New York), reported a reduction in induced HOAs following wavefront-guided treatment. However, no clinical differences in terms of visual acuity, patient preference, and mesopic contrast sensitivity were observed between the two treatments.

Another group of studies reported a significant superiority of wavefront-guided compared to conventional treatment in terms of night visual performance and glare symptoms.20,34 Schallhorn et al30 observed a significant improvement of night driving visual performance after wavefront-guided correction compared to conventional treatment.

Conventional Treatment vs Optimized Profile. Although several authors reported good visual outcomes and only a small increment in surgically induced HOAs after treatment with aspheric profiles,27,28 few comparative studies with conventional treatment are available in the peer-reviewed literature. Mastropasqua et al35 compared the visual outcomes and wavefront errors of 50 myopic eyes treated with photorefractive keratectomy (PRK) using an aspheric profile with the MEL 80 laser platform to 24 myopic eyes treated with a standard treatment using the MEL 70 laser platform. They found that both treatments caused an increase in HOAs. Nevertheless, the total wavefront error and spherical aberration were significantly lower with the aspheric profile compared to conventional treatment. de Ortueta et al36 compared 70 myopic eyes with conventional treatment with 70 eyes treated with an aspheric profile using the ESIRIS laser platform (SCHWIND eye-tech-solutions GmbH & Co KG). Their results were similar to those reported by Mastropasqua et al.35 with an increase of HOAs and spherical aberrations after ablation in both groups, but a smaller induction of HOAs after aspheric ablation than standard ablation.

When analyzing these data, despite showing a small reduction in the induction of HOAs with the wavefront-optimized profile, it is not possible to conclude that it leads to superior visual performance compared to the standard treatment.

RESULTS OF COMPARATIVE STUDIES BETWEEN DIFFERENT WAVEFRONT ABLATION PROFILES

Wavefront-guided vs Wavefront-optimized. Both of these profiles have suggested a smaller increase in HOAs postoperatively compared to the conventional treatment. The wavefront-optimized profile was introduced to preserve the natural prolate shape of the cornea and to compensate for the so-called “cosine effect.” The idea is also to reduce the variables that can influence the final outcome, resulting in a more simple procedure. In wavefront-guided treatments, as an ex-
ample, the quality of the wavefront map and correct axis alignment tend to be more crucial than in wavefront-optimized treatments.

To determine the place of this new algorithm in the strategy of treatment, Stonecipher and Kezirian,37 in a United States Food and Drug Administration trial, compared 374 myopic eyes randomized to receive either the wavefront-optimized profile or wavefront-guided profile (which was approved for use in the United States in 2003) using the Allegretto Wave Eye-Q. Regarding the visual outcomes after 3 months, most of the results analyzed did not show any statistically significant differences between groups, except for the percentage of eyes that achieved uncorrected distance visual acuity of 20/16, which was slightly higher in the wavefront-optimized group (76% vs 64%). Regarding postoperative wavefront errors, no difference was found between groups in 83% of eyes that had <0.30 μm of preoperative HOA root-mean-square (RMS). In eyes that had >0.30 μm of preoperative HOA RMS, the wavefront-guided profile resulted in less HOAs postoperatively than the wavefront-optimized profile. In terms of these results, the authors concluded that wavefront-guided treatment did not have an advantage over wavefront-optimized treatment in the majority of cases. They suggested wavefront-guided treatment be considered if the magnitude of preoperative HOA RMS is >0.35 μm, which represents approximately 20% to 25% of eyes in the overall general population. Other recent studies have supported these findings.38,39 Hantera29 reported similar results with the NAVEX, comparing the OATz algorithm (equivalent to the wavefront-optimized profile) to the optimized path difference custom aspheric treatment (equivalent to the wavefront-guided profile). The author found a greater tendency for increasing HOAs in eyes with <0.30 μm HOA RMS preoperatively in the wavefront-guided group. The reverse tendency was observed in the wavefront-optimized group. Therefore, the author recommended using the wavefront-optimized profile for eyes with preoperative HOA RMS <0.30 μm. Recently, Feng et al40 supported these findings in a meta-analysis including 7 studies and 930 eyes comparing wavefront-guided to wavefront-optimized LASIK for myopia. They reported no difference between profiles in terms of UDVA, corrected distance visual acuity (CDVA), and induction of HOAs for patients with preoperative HOA RMS <0.30 μm. However, in eyes with preoperative HOA RMS >0.30 μm, the wavefront-guided profile induced less postoperative HOAs than the wavefront-optimized profile.

In a prospective, randomized, double-masked study of 200 eyes that underwent LASIK for myopia and astigmatism, Yu et al41 found no statistically significant difference between treatments after 6 months. The variables analyzed included visual acuity, total HOAs, and contrast sensitivity in dim light conditions. An interesting finding in this study was the absence of a significant difference in patient satisfaction level after both treatments, evaluating night driving symptoms; visual symptoms such glare, halos, or ghost images; fluctuation of vision; and dryness. Perez-Strazieta et al,42 comparing 66 eyes receiving either wavefront-guided or wavefront-optimized LASIK, respectively, found similar results with no difference between groups in terms of UDVA, CDVA, manifest refraction spherical equivalent, and HOAs after 3 months. Another interesting finding in this study was that 14 eyes initially scheduled for wavefront-guided treatment had to be converted to wavefront-optimized for poor limbal ring alignment (8 eyes), a Wavescan that was inconsistent with the manifest refraction (5 eyes), and no iris registration (1 eye), indicating the high level of requirements for wavefront-guided compared to wavefront-optimized treatment.

George et al27 retrospectively evaluated the results of 285 eyes treated with the wavefront-optimized profile using the WaveLight Allegretto laser and found excellent visual outcomes with a low postoperative increase in HOAs of +0.03 μm for myopic LASIK and 0.00±0.07 μm spherical aberration induced after 3 months. Comparing these results to former outcomes obtained with the wavefront-guided treatment using the LADAR CustomCornea, they reported a greater increase in surgically induced spherical aberration with the wavefront-guided compared to the wavefront-optimized profile after myopic LASIK.

These results, although in contrast with previous studies comparing both ablation profiles, are consistent with the primary aim of the wavefront-optimized profile, which is to preserve the natural shape of the cornea without inducing ocular aberrations.

Custom-Q Profile. Koller et al43 compared this treatment algorithm to wavefront-guided ablation in a contralateral eye study of 35 patients treated with LASIK for myopia and astigmatism. They reported equal safety and efficacy using both treatments. Although the corneal asphericity was less impaired in the Q-factor profile up to −5.00 D, no statistically significant difference was noted regarding visual or optical parameters up to −9.00 D, except after 1 month when the wavefront-guided group had significantly lower coma-like aberration. The unexpected result was the similar induced spherical aberration in both groups. Ghoreishi et al,44 in a contralateral eye study comprising 56 patients, found similar results comparing one eye treated...
with custom-Q PRK targeted to a Q-value of −0.2 and the fellow eye treated with wavefront-guided PRK. They found no differences in terms of safety and visual outcomes and a similar increase in spherical aberrations postoperatively. Stojanovic et al45 compared this same algorithm of treatment with a target Q-value set to −0.5 or −0.6, depending on the patient’s preoperative asphericity and age, to the wavefront-optimized profile. All eyes showed a tendency towards an oblate shift postoperatively; however, less shift was noted in the Custom-Q group than in the wavefront-optimized group. No differences were found regarding safety, refractive outcomes, low contrast visual acuity, and wavefront errors.

Of the few studies available in the peer-reviewed literature comparing the custom-Q profile to other ablation profiles, most failed to demonstrate any superiority of this algorithm of treatment over another. These findings also suggest that the custom-Q profile was not able to deliver exactly the attempted asphericity with the current technology, probably affected also by an unexpected wound-healing response.

In a multivariate regression analysis of 160 eyes that underwent wavefront-guided treatment, Tuan and Chernyak46 found no significant correlation between the change in corneal shape and visual performance. The authors concluded that no standard optimal asphericity exists and the ideal shape needs to be customized on an individual basis.37

**LIMITING FACTORS**

**Patient-related Limitations**

Despite all technological improvements, final outcome is limited by patient-specific factors, such as wound healing and biomechanical response. Current excimer lasers are precise and can sculpt a plastic model with submicron precision. However, corneal wound-healing response tends to smooth features applied to the corneal stroma and potentially avoid the effect of the intended ablation to correct HOAs. As mentioned by Netto and Wilson,47 hyperplasia of the epithelium within the ablated zone by even a single cell is likely to have a major affect on a customized corneal treatment, given that the diameter of an epithelial cell is larger than the ablation volume to correct 1 μm RMS of wavefront irregularity in a single point.

Furthermore, regarding the biomechanical response, Dupps and Roberts48 suggested that a central ablation, by releasing tension in the periphery, can lead to expansion and thickening in the midperiphery causing a secondary flattening of the center and thus a change in curvature. These postoperative issues are known to hinder the accuracy of customized treatments and produce variable results because the majority of these profiles do not take into account these unexpected responses.

Wavefront-guided treatment aims to correct the preexisting aberrations and avoid the induction of significant amounts of aberrations to improve visual performance, but questions have been raised with recent publications showing that the total RMS of HOAs is not a reliable predictor of visual performance. It has been shown that visual acuity varied significantly depending on the combination of Zernike modes and the relative contribution of each mode.49 From these findings, it remains to be seen whether the treatment of all HOAs is more beneficial for visual performance and if not, which specific combinations of aberrations must be treated or, on the contrary, maintained or unchanged. Technology, such as adaptive optics, might be a useful tool to combine with wavefront technology to reach a higher level of customization. Preoperative patient simulations with different combinations of aberrations might help in determining the specific amount and Zernike mode of aberration to target with the treatment.

**Technology-related Limitations**

Wavefront sensors are precise and reproducible when dealing with low to moderate magnitudes of higher order aberrations. However, because the measurement of ocular aberrations is based on the position of a collection of spot images, if the eye is highly aberrated (decentered ablations, small optical zone, or irregular astigmatism), the spots overlap and the computer cannot determine the origin of an individual spot, reducing the precision of the measurement. In addition, data analysis by a wavefront sensor does not take into account the quality of individual spots formed by the lenslet array, which can cause false readings in opacities and disruption of the tear film. Furthermore, differences in the technology used by the different wavefront sensing devices such as Hartmann-Shack, Tscherning (position-based aberrometers), or dynamic skiascopy (time-based aberrometers) lead to different wavefront measurements, thereby further increasing the discrepancy in results.50

**Factors Limiting Interpretation and Analysis of the Available Results**

Due to the disparity in results among the different comparative studies, and although customized ablation seems to provide better outcomes than conventional ablation in terms of induced aberrations, it appears that no algorithm of treatment or excimer laser
<table>
<thead>
<tr>
<th>Study (y)</th>
<th>Profile</th>
<th>Eyes (N)</th>
<th>CL/NCL</th>
<th>P/R</th>
<th>Technique</th>
<th>Eximer Platform</th>
<th>Parameters analyzed</th>
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<tr>
<td>Bottos et al(^2) (2011)</td>
<td>WFG</td>
<td>209</td>
<td>NCL</td>
<td>R</td>
<td>PRK</td>
<td>FS laser</td>
<td>VISX S4</td>
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<td>P</td>
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<td>R</td>
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<td>Multiple</td>
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<td>50</td>
<td>NCL</td>
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<td>Amaris</td>
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<td>NCL</td>
<td>R</td>
<td>Keratome</td>
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<td>CL</td>
<td>P</td>
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<td>R</td>
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<td>ESIRIS</td>
<td>X</td>
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<td>NCL</td>
<td>P</td>
<td>FS laser</td>
<td>Allegretto</td>
<td>X</td>
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<tr>
<td>Yu et al(^13) (2008)</td>
<td>WFG vs WFO</td>
<td>200</td>
<td>NCL</td>
<td>P</td>
<td>Keratome</td>
<td>Allegretto</td>
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<tr>
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<td>CL</td>
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<td>R</td>
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<td>Allegretto</td>
<td>X</td>
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CL/NCL = contralateral/noncontralateral study, P/R = prospective/retrospective study, VA = visual acuity, WF = wavefront aberration error, CS = contrast sensitivity, WFG = wavefront-guided, WFO = wavefront-optimized, Cv = conventional, Q = adjusted Q profile, PRK = photorefractive keratectomy, FS = femtosecond

VISX S4 (Abbott Medical Optics Inc, Santa Ana, California); LADAR, Allegretto (Alcon Laboratories Inc, Ft Worth, Texas); Amaris (SCHWIND eye-tech-solutions, Kleinostheim, Germany); Zyoptix (Bausch & Lomb, Rochester, New York); MEL (Carl Zeiss Meditec, Jena, Germany); ESIRIS, CXIII (NIDEK Co Ltd, Gamagori, Japan).
platform has demonstrated a clear superiority over another. The main reason lies in the difficulties in analyzing and comparing findings among those different studies. The Table summarizes the disparities in study design and parameters analyzed among several comparative studies. The lack of standardization in patient selection, range of attempted correction, excimer laser platform and ablation algorithm used, nomogram adjustments, and visual function tested (visual acuity, contrast sensitivity, wavefront errors, or subjective patient satisfaction and visual symptoms) lead to a high degree of bias and significant discrepancies in the results. Furthermore, over the past 10 years, numerous improvements in excimer laser platforms such as faster repetition rates, faster eye trackers, and wavefront analyzers (providing more accurate measurements), may have led to superior outcomes, inducing more variables and thus further confusing the critical analysis of the results.

**PERSPECTIVES**

Despite the technological improvements and improvements in refractive outcomes in terms of induction of higher order aberrations and reduction of night vision symptoms compared to the standard procedure, it is now a well-known fact that wavefront-guided ablation profiles are not as effective as originally promised. It was demonstrated that wavefront-based ablation profiles could lead to incomplete correction of HOAs or induction of additional aberrations, especially when higher refractive corrections are required. The reason is believed to be due to an inaccurate transfer of a theoretically calculated ablation profile to the cornea by simplifying the effect of the multi-lens system of the eye. As suggested by Mrochen et al only an individualized eye model, based on an optical ray tracing algorithm, can provide an ideal ablation profile by achieving the highest degree of customization.

This eye model is obtained by taking into account the following parameters: wavefront of the entire eye, shape and curvature of the anterior and posterior surface of the cornea, corneal and lens thicknesses, anterior chamber depth, axial ocular length, and after an optimization process, the data related to the lens surface. Unpublished data collected in the first European multicenter clinical trial on the ray tracing ablation profile demonstrated excellent safety and efficacy visual outcomes. After 3 months, 75% of eyes gained one line of CDVA and 5% gained two lines, whereas no eyes lost lines. These results seem to be promising and if a clinically significant effect is confirmed, this ray tracing ablation profile may be able to fulfill the promise of “super vision.”

**AUTHOR CONTRIBUTIONS**

Study concept and design (D.S.); data collection (D.S.); analysis and interpretation of data (D.S., G.R.M., M.R.S., R.R.K.); drafting of the manuscript (D.S., G.R.M.); critical revision of the manuscript (M.R.S., R.R.K.); supervision (R.R.K.)

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AUTHOR QUERIES

Your repeatedly mention that no algorithm has proven to be superior over another. Please remove all repetitive statements throughout the paper.

Regarding reference 8, did Dr Artal present a talk at this meeting? Did the author speak during the talk or after?

The following was changed. Okay as edited?
Original: Decreased quality of vision reported by the patient as blurred vision under low light conditions, halos, and glare are the main complaints after conventional excimer laser refractive surgery.13
Edited: The main complaints reported by patients after conventional excimer laser refractive surgery are blurred vision under low light conditions, halos, and glare, which lead to decreased visual quality.13

Please clarify the following.
Following the company-driven technological developments, several studies comparing different wavefront-guided laser platforms have been published despite the bias introduced such as the familiarization to the use of a new platform and the need for nomogram adjustment that is surgeon-dependent.

Please clarify the following.
These findings also suggest that the custom-Q profile was not able to deliver exactly the attempted asphericity with the current technology, probably affected also by an unexpected wound healing response.

Please clarify the following.
However, corneal wound-healing response tends to smooth features applied to the corneal stroma and potentially avoid the effect of the intended ablation to correct HOAs.

Please provide a source and year for the unpublished data in the last paragraph of the article.
In unpublished data collected in the first European multicenter clinical trial on the ray tracing ablation profile, excellent safety and efficacy visual outcomes were reported. After 3 months, 75% of eyes have gained one line of CDVA and 5% gained two lines, whereas no eyes lost lines.

In the last sentence of the article, “super normal vision” was changed to “super vision,” as used in the Abstract and Introduction. Okay as edited?

In the Table, Femto was changed to FS laser and MK was changed to keratome. Okay as edited?