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Mini Review

Topography Guided Treatment in Myopia in Virgin Eyes

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ABSTRACT

With recent advancements, newer LASIK (Laser-Assisted Keratomileusis) ablation profiles aim at decreasing or at least minimizing the induction of higher order aberrations. These higher order aberrations are the cause of decrease in quality of vision, including subjective visual symptoms of glare, haloes and reduced contrast sensitivity. Expansion of various corneal imaging modalities has helped a LASIK surgeon to provide a customized ablation profile with desirable outcomes. Topo-guided ablation profile is considered to induce lesser higher order aberrations along with causing a lesser tissue ablation providing a higher safety margin (in most of the studies). This customized profile can encounter hurdles in treatment of irregular corneas (post refractive surgery decentered corneas or those having a small ablation zone) and also is capable of tackling myopia with high astigmatism with excellent visual outcomes.

Keywords: Laser keratomileusis; Myopia; Topo-guided Ablation; Astigmatism

INTRODUCTION

LASIK as a corneal refractive procedure has gained widespread popularity for its safety, accuracy, excellent visual outcomes and minimal patient discomfort. Like most standard refractive surgical procedures, it is known to eliminate conventional refractive errors-Lower Order Aberration (LOA) like myopia, hyperopia and astigmatism; leaving the Higher Order Aberrations (HOA) uncorrected or inducing them, particularly coma and spherical aberrations resulting in postoperative complaints of glare, starbursts and halo [1-3]. With better understanding of optical aberrations and advancement in technologies, customized ablation profiles for LASIK have been introduced including Wavefront-Optimized (WFO), topography-guided profile as well as wavefront guided profiles.

The wavefront-optimized ablation profile minimizes the post-operative induction of spherical aberration (HOA) by taking into account the anatomically prolate cornea i.e. the normally aspheric cornea. However it does not address the preexisting higher order aberrations. The wavefront-guided ablation profile aims to correct both the preexisting LOA as well as the HOA of the eye [4]. Topography-Guided laser correction (TG) is a surface ablation profile, which uses corneal topographic images to generate a custom ablation profile. It tends to target the laser spots to flatten the steep portions (or the peaks of the mountain) and steepen the flatter areas or in other words ablates around the troughs or the flatter areas. It is customized to take into account, the corneal topography, which is unique to every eye, thus making it a more personalized ablation profile. This latest profile, while correcting the refractive errors and maintaining the normal aspheric corneal anatomy, also neutralizes the corneal irregularities. Compared with wavefront measurement with aberrometers, topographic measurements from the corneal surface can potentially measure more points including more in the periphery, where most of the aberrations lie. Moreover, corneal topography is unaffected by pupil size, accommodative status and centroid shift or by internal optical components such as cataract. One of the most important supremacy of TG treatment is its application in highly aberrated eyes or where inaccurate results are obtained with an aberrometer. Thus the data acquired using the topography is much more repeatable, stable and reliable [5,6]. Although traditionally this platform has been used to treat irregular corneas, studies have also documented its safety and efficacy in the treatment of primary myopia and astigmatism.

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Topo-guided platforms

Platforms on which TG lasers perform include corneal wavefront analyser with atlas 900 corneal topographer (Carl Zeiss Meditec), Alcon's Contoura vision, which uses Wavelight Topolyser Wavelight Topolyzer VARIO diagnostic device, proprietary treatment-planning software and the Allegretto Wave Eye-Q or WaveLight EX500 Excimer Laser systems; NIDEK's EC-5000 Advanced Vision Excimer laser system (NAVEX), comprising the Quest M2/EC-5000CX, OPD-Scan III and Final Fit custom ablation software; and Johnson & Johnson Vision's iDESIGN Refractive Studio, which measures wavefront analysis and corneal topography and then combines them to generate a custom LASIK procedure for each patient. Topography based platforms are created by converting a height map of the cornea using a Zernike or Fourier matrix, which can be used to generate a profile for ablation [7]. All the platforms work equally well in terms of lower magnitudes of astigmatism. However, the clinically refractive astigmatism and topography-measured corneal astigmatism are not always similar. This raises the question as to what should be taken into account to maximize the outcomes when patient has a refractive error with high astigmatism. Therefore, a new TG ablation Protocol (Contoura on the Wavelight laser) has been developed using the topography measured refraction (Contoura with Layer Yolked Reduction of Astigmatism [LYRA]). Motwani et al. [8] in their study showed that Higher Order Aberrations (HOA) interacting with lower order astigmatism is the main reason for the differences between manifest refraction and Contoura measured astigmatism, and the link between these can be successfully treated using Contoura with LYRA protocol.

Coming to recent advancements, the newer Phorcides Analytic Engine software [9] was introduced to assist the surgeon in fully extracting the power of TG system. Phoricides uses Geographic Imaging Software (GIS) to analyze the topography of each area of the cornea and identify visually significant areas of elevation. Like in geology, elevated mound of a hill is called talus; small elevations on topography have also been given the same name. Each talus is carefully analyzed by the GIS using optical physics to quantify the magnitude and direction of the induced astigmatism (as a vector).

LITERATURE REVIEW

Various studies have been published comparing WFO and TG ablation profile for refractive vision correction in myopic eyes. In a prospective comparative contralateral eye study of 84 patients by El Awady et al. [10] comparing WFO in one eye and TG in the other; revealed that the refractive results were similar in both the groups. However, vertical coma and higher cylindrical aberrations were lower in the topography-guided group than in the wavefront–optimized group.

Stulting et al. [5] in their study comprising of 249 eyes undergoing TG custom ablation treatment to correct myopia and myopic astigmatism (<6D) using Allegrretto Wave Eye-Q excimer laser and Allegro Topolyser for determining corneal topography; found that this treatment delivered predictable refractive outcomes through 12 months follow up. Another prospective contralateral eye study by Kim et al. [11] on 43 patients also concluded superiority of TG LASIK in induction of fewer HOA'S and significantly decreased trefoil, corneal total HOA and coma. In terms of visual outcomes both the ablation profiles were equally safe and effective.

Jain et al. [12] in their contralateral eye study of 35 patients have compared outcomes of TG and WFO group in terms of visual acuity, ablation depth and higher order aberrations. The number of patients achieving a postoperative UDVA of -0.1 logMAR was 28.57% in topography-guided group verses 14.29% in wavefront-optimized group. Another outcome was that significantly less stromal tissue was ablated in the TG group than in the WFA group ($p<0.001$). They concluded that, compared to wavefront-optimized LASIK; topography-guided LASIK offers 1) better contrast sensitivity under mesopic light condition, 2) lesser induction of HOA, especially coma and spherical aberrations, 3) lesser amount of corneal tissue ablation and 4) better refractive outcome. Similar results in terms of equivalent visual outcomes and fewer induction of lower and higher order aberration in TG treatment was found by Shetty et al. [13]. In addition they also noted less change in Q value (measure of corneal ashpericity) in topography-guided group ($p>0.05$). This 30-patient (60 eyes) contralateral-eye, 6-month study used Pentacam HR (Oculus Optikgerate, GmbH, Wetzlar, Germany) and Allegretto Topolyzer (Alcon Laboratories, Inc.) as their aberrometers.

A meta-analysis was performed in 2021 by Hu et al. [14] to establish the superiority of each platform for myopic laser correction. To summarize the results of this analysis, both the methods were effective, however, TG-LASIK was safer, induced lesser HOA's and provided better postoperative predictability than WFO-LASIK.

DISCUSSION

Topo-guided ablation profiles definitely have proved to have an edge over other profiles in terms of higher order aberrations in patients of Myopia undergoing LASIK. Moreover, this platform induces less change in asphericity (Q value). The only concern is that this may result in unmasking of the lenticular HOA's. We believe that it may be highly useful in patients with significant irregular corneas. Numerous studies have described its utility in kerectasia, post keratoplasty, small or decentered optical zones, and flap interface complications. Small diameter of the optical zone post kerato-refractive surgery results in compromised visual function, halos, and glare in mesopic conditions and monocular diplopia in some cases especially in myopic ablations for over 7 diopters sphere. Topography-guided enlargement of the ablation zone has been shown to be effective in improving corneal surface regularity, thus reducing patient symptoms [15].

Management of highly decentered ablation using the topography-guided ablation on the Wave Light ALLEGRETTO platform and custom topographic neutralizing technique was described by Lin et al. in 2008 [16] Low amount of decentration of 0.5-1.0 mm affects low-contrast visual acuity and induces higher-order aberrations, whereas decentration of more than 1.0 mm (significant decentration) causes highly compromised visual

performance. Till date, arcuate cuts and laser photo ablative techniques, such as diametral ablation, masked ablations through collagen-based lenticules, and the Nizzola and Vinciguerra technique have been adopted for surgical management of decentered ablations when the option of contact lens fails [17]. Topography-guided customized ablation by excimer laser is a potentially effective technique for treating decentrations and irregular astigmatism.

CONCLUSION

As refractive surgery technology becomes more advanced, vision of 20/20 is just not enough. The best quality of vision with no nighttime vision complaints and maybe vision better than 20/20 is what patients and surgeons alike seek after. Therefore the quest for the best customized LASIK- ablation profile, which induces the least HOA as well as ablates taking into account minute corneal irregularities will continue. Most of the studies did not find any significant difference in terms of visual outcome with an upper hand in induction of fewer HOA in patients undergoing topo-guided treatments. With newer algorithms (artificial intelligence based) like phorcides, there is minimal induction of higher order aberrations like coma and trefoil, in turn leading to higher patient satisfaction. A randomized prospective study with a large sample size and a long follow up will establish its worth in patients of myopia undergoing refractive surgery.

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