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ASSESSMENT OF SCHWIND ESIRIS EXCIMER LASER AND ORK-CAM SOFTWARE ABERROMETER IN ENHANCING NEAR VISION FUNCTION IN PRESBYOPIC PATIENTS WITH LOW TO MODERATE MYOPIA: A PROSPECTIVE STUDY ON TREATING HIGHER-ORDER ABERRATIONS

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ABSTRACT

This study aimed to assess the effectiveness of SCHWIND ESIRIS excimer laser combined with ORK-CAM software aberrometer in enhancing near vision among patients with low to moderate myopia. The impact of treating higher-order aberrations (HOAs) on near vision function was also investigated. A total of 26 presbyopic patients (52 eyes) with low to moderate myopia were included in the assessment. HOAs were measured, and wavefront-guided treatments were designed using ORK-CAM software aberrometers. Three months post-surgery, assessments were conducted, including uncorrected and best-corrected visual acuity, manifest refraction spherical equivalent (MRSE), HOA measurements, and contrast sensitivity. Distance corrected near acuity (DCNA), best-corrected near acuity (BCNA), and DCNA+Near were also evaluated. The mean age in group A was 47.46 years, while in group B, it was 45.2 years. Preoperative MRSE and total HOA values were 2.37 and 2.87 D, respectively, with no significant differences between the two groups. Postoperatively, UCVA, BCVA, MRSE, and contrast sensitivity showed no significant differences between the groups. However, a significant difference was observed in vertical coma between the groups ($P < 0.001$). Furthermore, DCNA significantly improved in group B ($P < 0.01$) compared to group A. The findings suggest that wavefront-guided ablation can enhance visual function and improve uncorrected near acuity in presbyopic patients, particularly when selectively treating HOAs in those with low to moderate myopia. It is worth noting that vertical coma was the only HOA not addressed in the treatment protocol.

Key words: : SCHWIND ESIRIS Excimer Laser, Ork-Cam Software Aberrometer, Higher-Order Aberrations (Hoas), Wave Front-Guided Ablation, Presbyopic Myopia.

INTRODUCTION

Presbyopia, a common age-related condition, results in a gradual loss of accommodation, leading to difficulty focusing on near objects [1]. Patients often require corrective spectacles for clear near vision and may experience impairment in intermediate vision over time. Surgical correction options for presbyopia can be categorized into two main approaches [2]. One approach aims to restore the eye's true accommodative function through procedures such as ciliary sclerotomy and scleral expansion followed by the implantation of accommodative intraocular lenses (IOLs) [3].

Alternatively, pseudoaccommodation can be achieved by increasing the depth of focus without providing true accommodative benefit.

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Medical options for pseudoaccommodation include multifocal intraocular lenses and conductive keratoplasty [4]. Monovision can also be achieved through excimer lasers or monofocal intraocular lenses [5]. In a case study, a 45-year-old male with moderate myopia underwent laser-assisted keratomileusis, resulting in improved unaided vision to 20/15 [6]. However, wavefront analysis revealed a significant induction of vertical coma in the minimally ablated area. Despite this, the patient experienced near acuity improvement, with a distance corrected near acuity measure of 20/20 postoperatively [7]. A prospective study was conducted to investigate whether individuals with low-to-moderate myopia and presbyopia could benefit from selective treatment of high-order aberrations.

METHODS AND PATIENTS

The study employing a sequential double-masked comparative approach in a prospective manner, with all participants providing written informed consent prior to enrollment.

Patients selected for the study consisted of 52 eyes from 26 individuals experiencing symptoms of presbyopia and aged over 40 years. Exclusions were made for patients with pachymetry measurements exceeding 500 mm and those with chronic eye diseases or lens opacities. All patients with low to moderate myopia demonstrated a minimum distance vision of 20/20. Those with a pupil diameter of 6.0 mm displayed a maximum of 0.2 meters of coma aberration. Random assignment placed patients into Group A or Group B. Group A comprised 15 patients (9 females, 6 males) with a mean age ranging from 43 to 51 years. Their mean manifest refraction spherical equivalent (MRSE) was -2.37 D, with an average root mean square (RMS) of 0.35 mm. Group B included 13 patients (10 females, 3 males) with ages ranging from 42 to 50 years (mean 45.2 years). The group exhibited an RMS average of 0.38 mm and an MRSE average of -2.87 D. Preoperative data for both groups, including age, gender, MRSE, RMS, and other parameters, are presented in Table 1.

Evaluation prior to surgery

All patients underwent assessments including best-corrected visual acuity (BCVA), manifest and cycloplegic refractions, and uncorrected distance visual acuity (UCVA). Near vision capabilities were evaluated using uncorrected near acuity (UCNA), best-corrected near acuity (BCNA), and distance-corrected near acuity (DCNA) tests at a distance of 20 cm. Corneal mapping was performed for each patient using the Humphrey® AtlasTM 993 Placido-disk corneal topographer, accompanied by pupil diameter measurements obtained with vector Vision, Inc. The Haag-Streit BM 900 chart and ORK-CAM software (SCHWIND eye-tech-solutions) were utilized for slit lamp examinations to measure higher-order aberrations (HOAs) and to design wavefront-guided treatments for all patients. In Group A, treatment was administered to correct the sphere, cylinder, and all HOAs, whereas in Group B, no treatment was applied specifically targeting vertical coma aberrations.

Surgery technics

In all patients undergoing laser-assisted in situ keratomileusis (LASIK), flaps were created using a Moria M2 mechanical microkeratome. The intended dimensions for the flap were a diameter of 9.5 mm and a thickness of 130 μm. For the surgical procedure, a wavefront-guided excimer laser platform from SCHWIND eye-technology solutions was utilized in both groups.

Analyzing data and following up

Follow-up visits were scheduled for double-masked recipients at one day, one week, one month, and three months postoperatively. During the evaluations, distance uncorrected visual acuities (UCVAs) and best-corrected visual acuities (BCVAs) were assessed, manifest refractions were determined, and near UCVAs, BCVAs, and distance-corrected near acuities (DCNAs) were measured. Epithelial topography, contrast sensitivity, and aberrometry were conducted at one and three months postoperatively. Statistical analysis was performed using Microsoft Excel 2003 Data Analysis Tool Pak (Microsoft Corp, Redmond, WA). Comparison of means was carried out using a paired Student's t-test.

RESULTS

At the 3-month postoperative mark, there were no statistically significant differences in best-corrected visual acuity (BCVA) levels compared to preoperative BCVA levels for both Group A and Group B. The safety index, which compares postoperative BCVA to preoperative BCVA, was 1.0 for Group A and 1.1 for Group B, indicating a stable postoperative visual outcome. Both groups showed significant improvements in uncorrected visual acuity (UCVA) postoperatively, with all cases achieving at least 20/30 UCVA. By the 3-month follow-up, 80% of cases in Group A and 70% of cases in Group B achieved emmetropia. However, neither group had patients with emmetropia beyond 1.0 diopter.

Acuity of near vision

There were no statistically significant differences observed between the preoperative and 3-month postoperative best corrected near acuity (BCNA) levels in either group. The postoperative BCNA remained statistically insignificant at the 3-month mark for both groups. However, a significant difference was detected between patients in Group B and Group A regarding uncorrected near acuity (UCNA) ($P = 0.001$). Postoperative distance corrected near acuity (DCNA) demonstrated a significant improvement in patients from Group B compared to preoperative levels, whereas no notable difference was observed in patients from Group A.

Contrast sensitivity and HOAs

There was a notable distinction observed between Group B and Group A in terms of vertical coma three months after the surgeries ($P < 0.003$). However, no significant differences were noted between the two groups regarding other aberrations during the postoperative period. The pre- and postoperative values for higher-order aberrations (HOAs) did not display significant differences between groups, except for the vertical coma in Group B, which demonstrated a significant increase at the 3-month mark postoperatively ($P < 0.05$). Following the procedure, both groups exhibited a substantial improvement in contrast sensitivity. However, there were no significant differences in contrast sensitivity observed between the groups in the postoperative period.

Table 1: MRSE, RMS, and root mean square results showed no statistically significant difference between both groups preoperatively.

Group	A	B
No of eyes	60	44
Age (years)	47.46 (range 43–51)	45.2 (range 42–50)
Sex	18 females, 12 males	16 females, 6 males
MRSE	-3.38 D (range -2.76 to -5.0)	3.88 D -3.88 D (range -3.0 to -5.6)
RMS	0.36 μm (range 0.27–0.54)	0.39 μm (range 0.29–0.57)

DISCUSSION

Addressing presbyopia through refractive surgery in ophthalmology poses numerous challenges, primarily due to the incomplete understanding of its pathology and accommodation mechanism [8]. Unlike other refractive errors, presbyopia progresses steadily over time, exacerbating visual limitations. Several studies have linked specific visual symptoms to various types of higher-order aberrations (HOAs), underscoring the significant impact of wavefront aberrations on vision [9]. A study found positive correlations between double vision and total coma, as well as negative associations between starburst and total coma with a pupil size of 7 mm [10]. Similarly, horizontal diplopia was positively correlated with double vision and horizontal coma, while glare and starburst were associated with spherical aberrations and total aberrations. Coma aberrations exhibit variability based on pupil size, typically ranging between 0.28 and 0.35 μm for pupils larger than 7.0 mm. However, the impact of vertical coma on near vision capabilities remains unclear.

CONCLUSION

There is speculation that vertical coma, at certain degrees, might enhance depth of focus and consequently improve near vision. Nevertheless, this hypothesis requires further validation through expanded case studies and prolonged follow-up assessments.

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