Original Article

Stereoscopic Changes After Photorefractive Keratectomy In Myopia

Stereoacuity Changes following Photorefractive Keratectomy in Myopic Eyes

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ABSTRACT

Objective: To find out the stereoscopic changes after photorefractive keratectomy in myopia.
Study Design: Prospective study
Place and Duration of Study: This study was conducted at the Alhaitham Teaching Eye Center, Baghdad, Iraq from 15th April 2025 to 14th October 2025.
Methods: 44 cases of 88 eyes had photorefractive keratectomy achieving emmetropia. The patients had preoperative assessment, their stereoacuity was evaluated using TNO test charts positioned at a distance of 40 cm, this assessment took place 1 week before the scheduled surgery. Subsequently, follow-up evaluation was conducted at 4 week following the operation. Patients who had amblyopia were excluded from the study.
Results: The average age was 25.98±5.4 years, with 19 (43.2%) males and 25 (56.8%) females. Photorefractive keratectomy was uneventful in enrolled individuals. The mean preoperative stereoscopic vision was 220.4±142.2″. After the surgical procedure, the measurement of mean stereoacuity yielded value of 165.17±144.3″ at 4 weeks. Statistical significance between preoperative and 4 weeks (P=0.013) and notable improvement in postoperative stereoacuity among anisometropic participants.
Conclusion: Photorefractive keratectomy has the potential to improve visual acuity and stereoacuity in a substantial proportion of patients who undergo uneventful operation. The individuals diagnosed with an isometropia owned the most improvement in terms of heightened stereoacuity.

Key Words: Stereoacuity, Stereoscopic vision, Stereopsis, Photorefractive, Keratectomy, Refractive surgery, Myopia

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INTRODUCTION

In contrast to other visual capabilities, 3-D vision requires eye coordination, and thus creates its own unique category of visual capability. 3-D vision can be considered the ultimate example of eye cooperation and takes place whenever there is a certain amount of difference between the retinal images created by both eyes, without creating double vision. [1] Stereopsis as an aspect of vision can be defined as the ability to distinguish between what each eye sees differently because of the differences in the position of each eye on the head.[2]

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Factors that degrade stereopsis include visual acuity, aniseikonia, pupil size, refractive error, eye dominance, accommodation, contrast sensitivity, heterophoria, and age.[3] Interpupillary distance (IPD) is another important component; SA increases with higher IPD.[4] It is unclear in the healthy population whether distance has a substantial impact on stereopsis outcomes or has no impact on the measurement of SA.[5] Changes in target shape and size and disparity types had no discernible impact on SA.[6]

There are several ways by which stereopsis is measured, but the results vary depending on the type of use, resulting in a lack of correlation between various stereopsis tests. The differences could be due to the size, shape, and degree of familiarity of symbols used for testing, differences in viewing distances, or the wearing of glasses.[7] Stereopsis tests are classified into two types: contour and random dot. The contour tests include Titmus circle test, while random dot tests include the TNO test. Since disparities are different for each test, neural processing would vary based on these disparities.[8] According to Fawcett, stereopsis measurements of healthy people were not significantly different using the Titmus circle test, Randot circle test, and Preschool Randot (random dot).[9]

According to World Health Organization, uncorrected refractive error is the most prevalent source of moderate-to-severe vision loss, responsible for 43% of such occurrences in the world (equivalent to 122 million people).[10] Three methods can be used to correct refractive error problems, including eyeglasses, contact lenses and surgery, more and more patients are now inclined toward surgeries, which include laser eye surgeries and corneal transplant surgeries.[11] Refractive surgeries can be considered not only for refractive purposes, but also as an option for patients with preoperative binocular vision disorders and normal subjects could alter their preoperative normal binocularity.[12] The success or failure rate of a refractive procedure is determined by its stability, safety, and predictability.[13] Surgical interventions involving refraction may greatly lower aniseikonia, and research has shown that changes in aniseikonia above a particular point may have negative impacts on stereopsis. Moreover, research has revealed that wearing sunglasses affects stereopsis more negatively than visual acuity. All refractive procedures have the potential to affect stereoacuity.[14,15]

The patients' satisfaction after a refractive surgery depends on their postoperative uncorrected visual acuity, preoperative expectations, and psychological factors.[16] Despite the excellent postoperative anatomical and optical outcomes, some patients complain of visual symptoms, suc has decreased contrast sensitivity, color vision and generally poor vision.[17]

Photorefractive keratectomy (PRK), a technique involving photoablation of the cornea by an excimer laser, was applied in myopia correction in the 1980.[18] PRK treatment is done at the corneal level, whereby the superficial corneal epithelium up to Bowman's membrane is removed completely, after which the surface of the cornea is remodeled using the excimer laser.[19] PRK is safe and effective in myopia treatment, with patients exhibiting relatively higher levels of satisfaction.[20] Moreover, PRK is less likely to cause ectasia compared to LASIK, and there is no threat of vision loss because there is no flap formation.[21]

Today, the main parameter for assessing the results of refractive surgeries is visual acuity. However, visual acuity is an aspect of vision that provides only are lative view of visual quality.[17,18] On the other hand, stereopsis, as the highest level of visual function, is not routinely measured before and after refractive surgeries, while its measurement is not strenuous.[22]

METHODS

This prospective study was conducted at Ibn Alhaitham Teaching Eye Center, Baghdad, Iraq from 15th April 2025 to 14th October 2025 vide letter No. 124/QM/Approval/dfdfd Date April 3, 2025 and 44 cases of 88 eyes had photorefractive keratectomy with the goal of achieving emmetropia. The pre-operative spherical equivalent (SE) refraction varied from -0.5 to -6.5 dpt, whereas the pre-operative best corrected visual acuity (BCVA) was 6/9 or better. Monocular amblyopia, heterotropia identified through clinical examinations, ocular pathology alters visual function, prior ocular surgery, CCT less than 470 µm, hyperopia, BCVA worse than 6/9 were excluded.

Before undergoing refractive surgery, all participants had their medical history taken in a detailed manner in addition to an ophthalmic examination that was thorough and complete. The procedures included a visual acuity or a refraction, intraocular pressure, ocular alignment, and motility, stereoacuity, slit-lamp examination, and effective corneal topography that was performed with the aid of the Sirius Scheimpflug-Placido device.

An experienced optometrist carried out the stereopsis assessment according to manufacturer's instructions using the TNO test in standardized photopic conditions at 40 cm. Measurement of x-ray was recorded before surgery and again at one and four weeks after surgery.

A single surgeon used the MEL® 90 excimer laser system (Carl Zeiss Meditec) to perform all procedures that permit real-time eye tracking, ablation, and adjustment.

Prior to surgery, topical anesthesia and povidone-iodine antisepsis were administered, followed by debridement of corneal epithelium and photoablation with excimer laser. For all the patients, the optical zone was set at 6.5 mm with 0.02% Mitomycin C. This was followed by saline irrigation and placing of bandage contact lens. The patient was given topical moxifloxacin, and prednisolone, and preservative-free artificial tears in the postoperative period. The medications were gradually tapered as per the healing.

The data have subsequently analyzed using SPSS Version 23. The categorical variables have compared using Chi-square test/Fisher's exact test and numerical variables were analyzed using ANOVA with Tukey post hoc test. The Mann-Whitney U test and Wilcoxon Signed Rank test were used to analyse non-normal data. A p-value of less than 0.05 showed significance.

RESULTS

The average age was 25.98±5.4 years. There were 19 (43.2%) male and 25 (56.8%) female. The preoperative mean spherical equivalent was-2.92±1.42 dpt, Prior to the surgical procedure, 22 (50%) patients exhibited stereoacuity ranging from 240 to 480 arc sec, 19 patients (43.2%) between 60 and 120 arc sec and 3 patients (6.8%) within the range of 15 to 30 arc sec. At four weeks postoperatively, none of the patients exhibited lack of stereopsis, 15 (34.1%) had 240-480″, 18 (40.9%) had 60-120″ and 11 (25%) had 15-30″ (Table 1).

When examining the alteration in stereoacuity relative to baseline, it was seen that after a duration of four weeks, only 3 individuals accounting for 4.5% of the 8 sample, had a deterioration in SA, conversely, 16 representing (36.4%) of the samples shown an improvement in SA (Table 2).

There was statistically significant alteration in mean SA before operation and 4 weeks postoperatively with better SA of 165.17″±144.3″ (Table 3). There was no statistically significant difference in mean ages of patients and the change in SA at 4 weeks, while patients with higher CCT was at higher risk for having their stereoacuity deteriorated (Table 4).

There were no statistically significant differences between cases with SE <-3.0 dpt or ≥-3.0 dpt in regards to SA at any examination time, in addition, there was no statistically significant differences of preoperative SA in comparison to 4 weeks postoperatively (Table 5).

Cases with preoperative anisometropia of atleast 2 dpt was 6 patients, 5 of them had significantly improved SA at 4weeks postoperatively in comparison to both cases with no preoperative anisometropia, and also in comparison to preoperative SA (Table 6). There was no statistically significant difference in SA change and sexes (Table 7).

Table No. 1: Stereoacuity of the study group before and after photorefractive keratectomy

Stereoacuity	Preoperative		4 weeks postop	
	No.	%	No.	%
Nostereopsis	-	-	-	-
240-480″	22	50.0	15	34.1
60-120″	19	43.2	18	40.9
15-30″	3	6.8	11	25.0
Total	44	100.0	44	100.0

Table No. 2: Changes in stereoacuity postoperatively in comparison to baseline

Stereoacuity	4 weeks postoperative	
	No.	%
Deteriorated	3	6.8
Unchanged	25	56.8
Improved	16	36.4

Table No. 3: Pairwise comparison between preoperative SA with four4 weeks postoperative

Time of examination	Stereoacuity in arc sec	P value
Preoperative	220.40±142.2″	0.013
4 weeks postop	165.17±144.3″	

Table No. 4: Distribution of age, CCT and SE according to change of stereoacuity at 4 weeks post PRK

4-weeks postoperative stereoacuity change	Age		CCT		SE	
	Mean	SD	Mean	SD	Mean	SD
Deteriorated	28.00	8.0	568.33	34.7	-2.54	0.94
Unchanged	26.44	5.03	528.98	35.80	-3.09	1.15
Improved	24.88	5.73	525.16	20.18	-2.73	1.81
P value	0.543		0.009		0.434	

Table No. 5: Comparison of stereoacuity according to spherical equivalent and time of examination

Time of examination	Stereoacuity in arc sec				P value*
	SE < -3.0 dpt		SE ≥ -3.0 dpt		
	Mean	SD	Mean	SD	
Preoperative	237.98	146.67	195.00	135.44	0.461
4 weeks postoperative	178.27	148.83	146.25	139.40	0.507
P-value compared to preoperative**	0.051		0.105		

*Mann Whitney U test for two independent samples,**Related-Samples Wilcoxon Signed Rank Test

Table 6: Comparison of stereoacuity according to anisometropia ≥2.0 dpt and time of examination

Time of examination	Stereoacuity in arc sec				P value*
	No anisometropia		Anisometropia		
	Mean	SD	Mean	SD	
Preoperative	212.57	142.65	270.00	139.43	0.461
4 weeks postoperative	182.37	145.57	56.25	36.97	0.507
P-value compared to preoperative**	0.110		0.041		

*Mann Whitney U test for two independent samples,**Related-Samples Wilcoxon Signed Rank Test

Table No. 7: Distribution of sexes according to change of stereoacuity at 1 and 4 weeks postoperative PRK

Time of examination	Sex	Deteriorated	Unchanged	Improved	P value
4 weeks postoperative steroacuity change	Male	-	10 (52.6%)	8 (42.1%)	0.891
	Female	2 (%)	15 (60%)	5 (20%)	

DISCUSSION

Despite exhibiting a visual acuity of 6/6 with a high contrast and the absence of any remaining refractive errors, a number of patients have expressed dissatisfaction with the quality of their vision after refractive procedures. Stereopsis is a crucial element of binocular vision. Stereoacuity is a fundamental prerequisite to certain occupations, like as ophthalmic surgery.[23] The presence of impaired stereopsis has been shown to be correlated with worse microsurgical ability, suggesting potential implications for the field of surgical training.[24] A recently was explored the relevance and significance of stereoscopic vision in the visualization of anatomy among medical students.[25]

This was seen in the present study where 36.36% cases improved, 6.81% cases worsened and 56.81% cases remained stable in stereoacutiy over 4 weeks after photorefractive keratectomy. The mean stereoacuity rose from 220.4±142.8 to 165.17±144.27arc seconds. According to Maden et al[26], Jabbarvand et al[27], Gyldenkerne et al[28] and Marvivic et al[29], stereoacuity or binocular vision improved after surgery in each of these studies.

Anisometropia can cause an imbalance in the vision of both eyes. The present study showed that patients with this condition had a remarkable improvement in stereoacuity after surgery. In fact, mean value improved from 270±139.43 to 56.25±36.97 arc seconds as five out of six patients became better stereoscopic vision. The findings indicate agreement with other studies.[29,30] Liu et al[31] also found stereopsis to improve primarily in patients with aniso-metropia greater than or equal to 2.5 D, probably to inhibit foveal suppression and improvement in retinal image quality.[32] After the treatment of anisometropia monocular blur and a binocular imbalance, the stereopsis improved. Myopic anisometropia shows worse stereoacuity according to Nabie et al.[33] In the current study, patients with preoperative myopia of ≥3 diopters did not demonstrate a significant impact on stereoacuity, similar to Singh et al.[34] However, Jabbarvand et al[27] reported a greater improvement in stereoacuity in patients with higher degrees of myopia.

In comparison, Godt et al[35] and Zarei-Ghanavati et al[36] found a decrease in stereoacuity after the surgery, meaning not everyone achieved a normal stereoacuity. The causative factors may be decentred ablation, anisometropia, alteration of the location of the nodal point, prismatic changes.[31]

In highly myopic patients, binocular visual function was evaluated after SMILE surgery by Gyldenkerne et al[28] Earlier research shows that enhanced contrast sensitivity following wave front-guided refractive surgery improves stereoacuity, while dry eye disease post operation may temporarily reduce visual performance.

CONCLUSION

An overall improvement in stereoscopic vision 4-weeks following photorefractive keratotomy in myopic patients, particularly persons with anisometropia.

Author's Contribution:

Concept & Design or acquisition of analysis or interpretation of data:	Mohammed Qasim Alnuwaini, Alyaa Abood Kareem
Drafting or Revising Critically:	Mohammed Qasim Alnuwaini, Alyaa Abood Kareem
Final Approval of version:	All the above authors
Agreement to accountable for all aspects of work:	All the above authors

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