Comparative study of contrast sensitivity changes after laser in situ keratomileusis and photorefractive keratectomy in mild and moderate myopia

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Abstract

Background: The aim of our study was to compare the change difference in contrast sensitivity after laser in situ keratomileusis (LASIK) and photorefractive keratectomy (PRK) in cases of mild and moderate myopia.

Methods: Our study included 50 patients with a total number of one hundred eyes subdivided into 2 groups: the first group included 25 patients who underwent uneventful bilateral LASIK surgeries, and the second group included 25 patients who underwent uneventful bilateral PRK surgeries, age was ranging from 18 to 40 years old, with measurement of contrast sensitivity before and after surgeries 1 week, 1month and three months using the Pelli-robson contrast sensitivity chart.

Results: It was found that Contrast sensitivity changes were significantly higher in patients managed with PRK surgery than in patients managed with LASIK surgery.

Conclusion: Contrast sensitivity measurement is a good method as visual quality indicator after refractive surgeries such as LASIK and PRK.

Keywords : Contrast sensitivity, LASIK, PRK, visual acuity, pelli-robson

Introduction

Contrast sensitivity is a measure of the amount of contrast a person requires to see a target. Contrast sensitivity measurement differs from acuity measurement; acuity is a measure of the spatial-resolving ability of the visual system under conditions of very high contrast, whereas contrast sensitivity is a measure of the threshold contrast for seeing a target. (1)

Clinical tests for measuring contrast sensitivity include the Vistech, Cambridge, Regan, and Pelli-Robson. Contrast sensitivity tests with letters as optotypes, such as the Pelli-Robson, are quick, reliable, and repeatable means for studying contrast sensitivity and are often used clinically. (2)

The Pelli-Robson contrast sensitivity test is a wall chart measuring 90 vs. 60 cm (36 vs. 24 inches). The chart comprises 8 lines of letters with different contrasts. Each line has 6 letters; the first 3 letters (a triplet) on the left have more contrast than the 3 letters on the right. The contrast also decreases downward from line to line. The size of the letters is 4.9 vs. 4.9 cm (2 vs. 2 inches). The letters on the left of the top line have the highest contrast, 1 or 100%, and the letters on the right of the bottom line has the lowest contrast, 0.006 or 0.6%. On writing the result, the values of logarithmic contrast sensitivity (1/contrast) are given. There are different sets of letters on each side of the chart. The recommended testing distance of 1 m, which corresponds to

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a spatial frequency of approximately 1 cycle per degree (cpd) and a test distance of 3 m, . An add of +0.75 diopter (D) can be used if distance correction is needed. The logarithmic contrast sensitivity value of the last triplet, of which at least 2 letters are correctly seen, is marked as the result. The luminance of the test should be 85 candelas/m2 (cd/m2); the accepted range is 60 to 120 cd/m2. **(2)** The visual acuity is measured first then contrast sensitivity before and after laser in situ keratomileusis (LASIK) and photorefractive keratectomy (PRK).
In our study, we examined the spatial frequency of 3 cpd.

Purpose:

To compare the changes in contrast sensitivity after laser in situ keratomileusis (LASIK) and photorefractive keratectomy (PRK) in cases of mild and moderate myopia as an indication of visual function.

Patients and methods

Our study was conducted at Beni Suef University, involving 50 patients subdivided into 2 groups: 25 patients in the LASIK group and 25 patients in the PRK group within four months between March and June 2019 and verbal consent was obtained.

Inclusion criteria:

Clear cornea in patients aged 18-40 years old with mild to moderate myopia (up to – 6.00 D)

Exclusion criteria:

Ocular and systemic diseases affect the eye.
Corneal opacities or dystrophies.

All patients were subjected to: All participants underwent ophthalmological examination.

- vision assessment using the LogMAR chart
- Autoref
- Anterior segment examination using a slit lamp corresponding to a spatial frequency of approximately 3 cpd
- Fundus examination using direct and indirect ophthalmoscopy
- Intraocular pressure
- Pentacam
- Contrast sensitivity testing using Pelli-robson chart (preoperative and postoperative one week, one month and three months)

Statistical methodology

The collected data were organized, tabulated and statistically analyzed using SPSS software statistical computer package version 18 (SPSS Inc. USA). For quantitative data, the mean, standard deviation (SD) and range were calculated. Independent t-test was used to compare the two groups, while repeated measures ANOVA for comparing between pre and post-intervention readings within the group. Qualitative data were presented as numbers and percentages, and chi-square (χ^2) was used as a test of significance. For interpret the results of tests of significance, significance was adopted at $P \leq 0.05$.

Results

The total number of subjects meeting our criteria was 50 who underwent LASIK or PRK by measuring the contrast sensitivity before and after the operation in Beni-suef University Hospital with a total of 100 eyes included that were of two groups: the LASIK group and PRK. All patients were aged 18-40 years old.

The two groups had clear cornea, mild to moderate myopia (up to – 6.00 D) and no ocular or systemic diseases affecting the eye. The BCVA was at least 0.8 or better using the logMAR chart. Although luminance was not measured, all measurements were done in the same room with the same degree of illumination during the study. All PRK and LASIK procedures included were uneventful.

Table (1): Distribution according age groups: There was no statistically significant difference between study groups with regard to age.

Variable	LASIK group (N=25)		PRK group (N=25)		P-value
	Mean	SD	Mean	SD	
Age	26.4	4.9	26.9	4.4	0.652 (NS)

Table (2): Distribution according gender groups: There was no statistically significant difference between study groups with regard to sex.

Variable	LASIK group (N=25)		PRK group (N=25)		P-value
	N	%	N	%	
Sex					
Female	21	84.0%	17	68.0%	0.185 (NS)
Male	4	16.0%	8	32.0%	

The tables illustrate that there is no statistically significant difference (p-value >0.05) between the two operations with regard to demographic characteristics, age and sex that indicated proper matching between both operation groups.

Table (3): Changes in preoperative BCVA and postoperative UCVA in the 1 week, 1 month and 3 months after LASIK and PRK.

	LASIK group (N=50)	PRK group (N=50)	P-value
	Mean ± SD range		
BCVA			
Pre-operative	0.97 ± 0.06 0.8-1	0.96 ± 0.06 0.8-1	0.729 (NS)
After 1 week	0.94 ± 0.06 0.8-1	0.73 ± 0.05 0.6-0.8	<0.0001 (S)
After 1 month	0.97 ± 0.06 0.8-1	0.88 ± 0.06 0.7-1	<0.0001 (S)
After 3 months	0.97 ± 0.06 0.8-1	0.96 ± 0.06 0.8-1	0.729 (NS)
P-value: 1 W vs. Pre-operative	**<0.0001 (S)**	**<0.0001 (S)**	
P-value: 1 m vs. Pre-operative	**----**	**<0.0001 (S)**	
P-value: 3 ms vs. Pre-operative	**----**	**-----**	

The table illustrates that there was no statistically significant difference between study groups with regard to preoperative BCVA and postoperative UCVA at follow-up of three months. UCVA at one week was significantly higher in the LASIK group than in the PRK group (0.94 ± 0.06 vs. 0.73 ± 0.05), P value <0.0001. As well as, the LASIK group (0.97 ± 0.06) had a statistically significant higher UCVA at one month when compared to the PRK group (0.88 ± 0.06), p<0.0001.

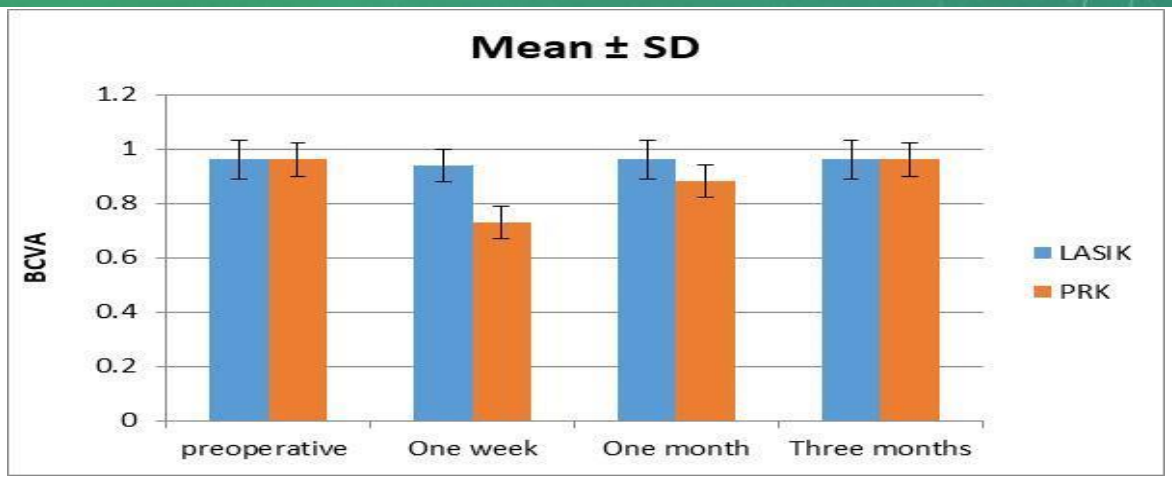

Figure (1): Changes in preoperative BCVA and postoperative UCVA in the 1 week, 1 month and 3 months after LASIK and PRK.

Table (4): Changes in preoperative and postoperative contrast sensitivity after 1 week, 1 month and 3 months after LASIK and PRK.

	LASIK group (N=50)	PRK group (N=50)	P-value
	Mean ± SD Range		
Contrast sensitivity			
Pre-operative	1.42 ± 0.1 1.25-1.55	1.44 ± 0.09 1.25-1.55	0.210 (NS)
After 1 week	1.29 ± 0.07 1.25-1.4	1.09 ± 0.04 0.95-1.1	<0.0001 (S)
After 1 month	1.35 ± 0.09 1.25-1.55	1.2 ± 0.07 1.1-1.25	<0.0001 (S)
After 3 months	1.41 ± 0.11 1.25-1.55	1.34 ± 0.07 1.25-1.4	0.001 (S)
P-value: 1 W vs. Pre-operative	**<0.0001 (S)**	**<0.0001 (S)**	
P-value: 1 m vs. Pre-operative	**<0.0001 (S)**	**<0.0001 (S)**	
P-value: 3 ms vs. Pre-operative	0.238 (NS)	**<0.0001 (S)**	

The table illustrates that there was a statistically significant difference between study groups with regard to preoperative and postoperative contrast sensitivity at follow-up of three months. Contrast sensitivity at one week was significantly higher in the LASIK group than in the PRK group (1.29 ± 0.07 vs. 1.09 ± 0.04), P value <0.0001. As well as, the LASIK group (1.35 ± 0.09) had a higher contrast sensitivity improvement at one month when compared to the PRK group (1.2 ± 0.07), P value <0.0001. After three months' postoperative, there was a statistically significant contrast sensitivity improvement nearly to preoperative values in the LASIK group (1.41 ± 0.11), while in the PRK group (1.34 ± 0.07), there was an improvement but did not reach the preoperative values with P value 0.017.

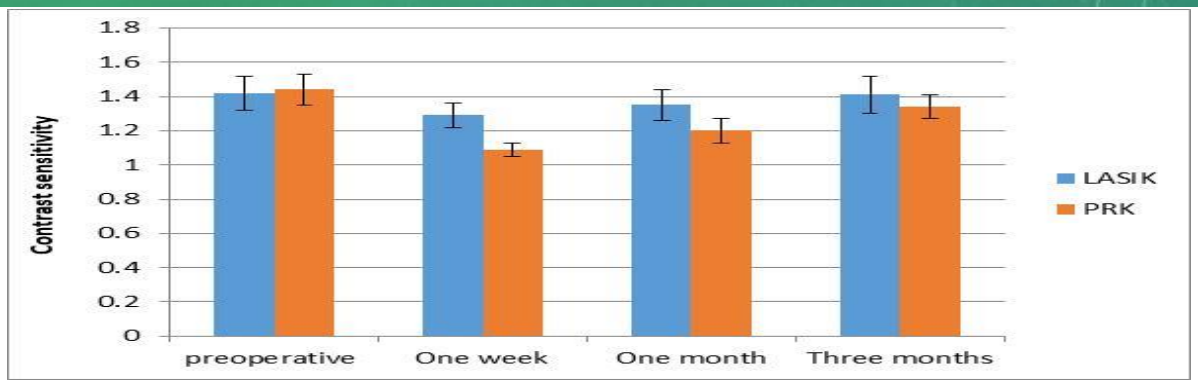

Figure (2): Changes in preoperative and postoperative contrast sensitivity after 1 week, 1 month and 3 months after LASIK and PRK.

5: Discussion:

The aim of our study was to compare the changes in contrast sensitivity after laser in situ keratomileusis (LASIK) and photorefractive keratectomy (PRK) in cases of mild and moderate myopia.

In our study, we compared contrast sensitivity, which is our primary outcome of the study and visual improvement after two refractive procedures (LASIK and PRK) in 50 patients divided into 2 groups, each containing 25 patients. Both procedures were done using a wavefront-optimized treatment by SCHWIND AMARIS 750s. In patients with PRK, we used the trans-PRK technique with MMC. In LASIK patients, the flap thickness was the same in all of them. All cases were done by one efficient surgeon. There were no complications detected intraoperative or postoperative on follow-up.

We found no significant difference in the UCVA after the operations compared to the preoperative values at 3 month follow-up, P= 0.296 for the right eye and 0.646 for the left eye; however, there was a marked and faster recovery in vision after 1 week, P <0.001 and 1 month with P <0.001 after LASIK compared to PRK.

We found a significant difference between the 2 procedures in effect on contrast, as contrast sensitivity decreased early at 1 week after LASIK and returned to preoperative values 3 months later. After the PRK procedure, it decreased and improved gradually after one week and after one month, but did not return to the preoperative values after 3 months.

In the LASIK group, the mean average of contrast sensitivity was 1.42 ± 0.1 before the procedure, and 1.29 ± 0.07 after 0ne week postoperatively with P value <0.0001 and 1.35 ± 0.09 after one month postoperatively with P value<0.0001. After 3 months post-LASIK, it was 1.41 ± 0.11, with a P value of 0.017.

In the PRK group, the mean average of contrast sensitivity was 1.44 ± 0.09 before the procedure and 1.09 ± 0.04 after 0ne week postoperatively with P value <0.0001 and 1.2 ± 0.07 after one month postoperatively with P value<0.0001. After 3 months post-PRK, it was 1.34 ± 0.07, with a P value of 0.017.

Other studies showed nearly similar results compared to ours: 76 eyes in

38 patients in the study were randomized to undergo PRK (n=20) and LASIK (n=18). There was a statistically significant reduction in contrast sensitivity at all spatial frequencies in PRK patients during the first and third month, but they recovered to preoperative values by 6 months after surgery. In LASIK patients, there were decreased contrast sensitivity values 1 month after surgery at all spatial frequencies. After 3 months, contrast sensitivity recovered and did not differ significantly from preoperative values. **(3)**

Other study included 34 eyes that had PRK and 55 eyes that had LASIK. The results were that retinal image quality was similarly reduced with PRK and LASIK, with no significant differences between the 2 methods. Some PRK patients had a residual refractive error that might have been related to corneal-wound healing still present 3 months postoperatively. **(4)**

Sandor Kaupp et al. study included a patient aged 21-42 years old, and 72% of the patients were male. They examined the contrast sensitivity function during recovery after LASIK and PRK. Preoperative and postoperative CSF was tested at 1, 2, 4, and 13 weeks after the surgery. CSF during recovery was significantly different between LASIK and PRK as of the LASIK eyes returned to the BL at 1st week post-surgery under photopic conditions and clinically insignificant reduction in mesopic CSF during the 13week period. At 1st week post-PRK, nearly 40% of the contrast sensitivity loss can be explained by optical aberrations (uncorrected refractive errors). It started to recover at the 2nd week and almost reached the LASIK level by the 4th week post-surgery. By the 13th week post-surgery, both photopic and mesopic CSF of the two groups were identical. **(5)**

The study by Ryan et al. included 215 participants with myopia ranging from -0.50 to -7.25 D divided into 2 groups that were planned to undergo either wavefront-guided or wavefront-optimized LASIK or PRK. They measured changes in viual acuity and contrast sensitivity function before and after the operation. They found a significant difference in contrast sensitivity function, with the most significant decrease occurring 1 month postoperatively. A comparison of the preoperative and 12 month CDVA showed a significant improvement in all groups. They concluded that wave front-guided and wavefront-optimized PRK and LASIK procedures maintained contrast sensitivity function at 12 months postoperatively, although the recovery period for visual performance was longer for PRK versus LASIK, there was no significant difference in treatment type or treatment profile at 12 months postoperatively. **(6)**

CONCLUSION

This study was performed mainly to identify the change difference in contrast sensitivity and visual improvement after refractive surgeries between LASIK and PRK.

In the LASIK group, the mean average of contrast sensitivity was 1.42 ± 0.1 before the procedure and 1.29 ± 0.07 after one week postoperatively with P <0.0001 and 1.35 ± 0.09 after one month postoperatively with P<0.0001. After 3 months post-LASIK, it was 1.41 ± 0.11 with a P value of 0.017.

In the PRK group, the mean average of contrast sensitivity was 1.44 ± 0.09 before the procedure and 1.09 ± 0.04 after one week postoperatively with P value <0.0001 and 1.2 ± 0.07 after one month postoperatively with P value<0.0001. After 3 months post-PRK, it was 1.34 ± 0.07, with a P value of 0.017.
It was found that there was a significant delay in the recovery of contrast sensitivity

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after three months in the PRK group more than LASIK group , P= 0.017. It returned to preoperative values 3 months after LASIK, P=0.161. After PRK, it improved but did not reach the preoperative values after 3 months, P <0.0001.

In our study, PRK and LASIK corrected almost all refractive errors in patients with mild to moderate myopia. Patients in the PRK group and patients in the LASIK group had a similar UCVA 3 months postoperatively, P=0.296 for right eyes and P=0.646 for left eyes. However, the postoperative UCVA values were worse early in the PRK group than in the LASIK group, probably because of the process of healing and haze may be present post-PRK.

Contrast sensitivity affects the visual outcome quality after refractive surgeries as LASIK and PRK. Thus, when contrast sensitivity decreases, the quality of vision is affected too. This is important in the preoperative examination and follow-up of refractive surgeries to measure contrast sensitivity with BCVA.

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