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Contrast Sensitivity Affection: A Comparative Study between Photorefractive Keratectomy and Small Incision Lenticule Extraction Pre and Postoperative

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ABSTRACT

Background: the cornea is a transparent dome shaped structure at the front of the eye separated from the iris and pupil by the anterior chamber. It is one of the main refractive media of the eye. Refractive surgery includes several types such as Photorefractive Refractive Keratectomy (PRK) and Small incision lenticule extraction (SMILE). **Objective:** contrast sensitivity affection in comparative study between patients undergoing photorefractive keratectomy (PRK) or small incision lenticule extraction (SMILE) surgery.

Patients and Methods: twenty cases of different patients' ages; 18-30 years old with myopia from -0.5 D to -9.00 D were included in this comparative study. Patient with corneal infection, trauma, opacities, operation, ocular disease or congenital eye disease were excluded from our study. All the selected patients were submitted to full ophthalmological examination (visual acuity, fundus examination, pantacam, and assess contrast sensitivity degree before operation and one month after refractive surgery. Measurement of contrast sensitivity was done by Function Acuity Contrast Test (FACT) before and one month after refractive surgery through several spatial frequencies (1.5, 3, 6, 12 and 18). **Results:** we found that contrast sensitivity was affected one month after refractive surgery in both groups but it is affected in group 1 after PRK more than group 2 that had femto SMILE.

Conclusion: contrast sensitivity was affected in both patients who had PRK or Femto SMILE after one month from operation but it is more stable after Femto SMILE.

Keywords: Cornea, PRK, SMILE, LASIK

INTRODUCTION

The cornea is a transparent dome shaped structure at the front of the eye separated from the iris and pupil by the anterior chamber. It is one of the main refractive media of the eye. The adult cornea measures 11 to 12 mm horizontally and 9 to 11 mm vertically. It is approximately 0.56 mm thick at the center, and increases gradually toward the periphery of the cornea where it is about 1mm thick. The radius of curvature of the anterior surface is about 7.8 mm and that of the posterior surface is about 6.9 mm [(1)]. The refractive power of the cornea is 42+ 2D diopters thus the cornea provides about 2/3 of the total refractive power of the eye which is 60 diopters [(1)]. Idea of photorefractive Keratectomy (PRK) involves removing the corneal epithelium either with the excimer laser or manually, Followed by computer guided ablation of the underlying Bowman's membrane and anterior corneal stroma for the correction of myopic or hyperopic refractive errors or both [(2)]. After improvements of scan modes and energy parameters; improved visual recovery times were noted, with refractive results similar to LASIK following the implementation of FLEX. A procedure called small incision lenticule extraction (SMILE) was developed, involving a small 2-3 mm incision used to allow for extraction of the whole corneal lenticule without the need to create a flap[(3)].

SMILE a relatively new refractive procedure designed to treat refractive errors such as myopia, hyperopia, presbyopia, and astigmatism. The procedure involves using a femtosecond laser to create corneal lenticule which is extracted as whole through a small incision without the use of an excrimer laser. It's reported to achieve effects similar to laser –assisted in site keratomileusis (LASIK) with excellent post operative outcomes[(3)].

Starting in 2007, an intra-stromal lenticule method was reintroduced as an alternative to LASIK called femtosecond lenticule extraction (FLEX) intended for patients with extreme myopia. SMILE is noted for achieving similar effects as LASIK but with some possible benefits such as faster recovery, less post operative dry eye, rapid re-innervation of corneal nerves, and potential biomechanical advantage. The commencement of this procedure began in September 2011 and is established in various locations such as Europe, China, and India. The Clinical trial in the USA began in June 2012 and has been expanded by the US FDA after initial signs of success in a small sample of patients; 255 patients have been treated at five centers in the USA. Outside of the USA, there are 150 centers in a total of 38 countries that perform the procedure[(3)].

The measurement of spatial contrast sensitivity documents visual function more comprehensively than visual acuity. The importance and usefulness of contrast sensitivity evaluation in patients who have undergone refractive surgery procedures is widely recognized. Measurements of

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contrast sensitivity assess the combined visual impact of any light scattering optical aberration, or defocus that may occur following refractive surgery [(4,5)]. This concept has been applied in several studies of refractive surgery [(6)].

However as noted by Watcher and Kruger, a major practical objection to contrast sensitivity measurement is the time required to evaluate contrast sensitivity at several spatial frequencies. This time is substantial even when simplified measurements procedure are used at only five spatial frequencies with commonly printed contrast sensitivity charts, such as the Vistech, Vector Vision CSV-1000E, or the stereo optical FACT charts. In view of this, it is reasonable to explore the value of the information provided at different spatial frequencies. If contrast sensitivity measurement at one or two spatial frequencies provides adequate information then the testing times will be correspondingly reduced[(7)].

AIM OF THE WORK

Contrast sensitivity affection in comparative study between patients undergoing photorefractive keratectomy (PRK) or small incision lenticule extraction (SMILE) surgery.

PATIENTS AND METHODS

All patients in this study undergo refractive surgery by two methods either (PRK) or (SMILE) forty eyes of different patients was included in this comparative study.

Inclusion Criteria:

- Age: 18- 30 years old patients undergoing refractive surgery by PRK or SMILE.
- Twenty cases of different with myopia from -0.5 D to -9.00 D were included in this comparative study.

Exclusion Criteria:

- Previous corneal operative.
- Corneal infection, trauma or opacities.
- Ocular disease.
- Congenital eye diseases.
- Keratoconus.
- Herpetic keratitis.
- Progressive myopia.
- Corneal disease.
- Glaucoma.
- Cataract.

Any other preexisting pathology of the cornea or anterior segment, including scarring, lagophthalmos, dry eye and blepharitis were -------. Absence of medical contraindications: Uncontrolled vascular disease, Autoimmune disease, Immunosuppressed/ immunocompromised and Pregnant or nursing women.

All the selected patients were submitted to full ophthalmological examination (visual acuity, fundus examination, pantacam, and assess contrast sensitivity degree before operation and one month after refractive surgery by Function Acuity Contrast Test (FACT).

Written informed consent:

The study was approved by the College Ethics Committee before being submitted to the University Council for Postgraduate Studies. Informed consent was obtained verbally and in writing from patients involved in the research.

Statistics Analysis

Statistical presentation and analysis of the study was conducted, using the mean, standard deviation (SD), ANOVA test and correlation coefficient by SPSS Version (20) statistical software (IBM Corporation, USA). Descriptive statistics was calculated and the data was summarized as mean ± SD. Comparisons between pre CXL data and post CXL data. Significance was considered when P value less than 0.05.

RESULTS

In our study we assessed contrast sensitivity degree before operation and one month after refractive surgery (PRK in group I, SMILE in group II) by Function Acuity Contrast Test (FACT) which depends on several spatial frequencies represented as 1.5, 3, 6, 12 and 18. Contrast sensitivity degree was recorded in each spatial frequency and represented finally by a curve showing contrast sensitivity degree of each patient before and one month after operation in both groups.

Table (1): Demographic characteristics of the studied 2 groups according to age

Age (years)	Group I	Group II
Range	23-30	20-30
Mean+ SD.	26.5+2.718	24.0+3.711

Table (**1**) shows Group I and Group II according to the age; the range of age in Group I was from 23-30 years old and the group II was from 20-30 years old the mean was 26.5±2.718 in Group I and the mean was 24.0±3.711 in Group II.

Table (2): Demographic characteristics of the studied 2 groups according to sex

Sex (years)	Group I	Group II
Male	5 (50%)	4 (40%)
Female	5 (50%)	6 (60%)
Mean+ SD.	1.5+0.527	1.6+0.516
T test	0.429	
P value	.678	

Table (**2**) shows no statistically difference between Group I and Group II. According to the sex the male was 5 (50%) and the female was 5 (50%) in Group I and the male was 4 (40%) and the female was 6 (60%) in group II with no significant difference also between the two groups as the P value was 0.678.

Table (3): Demographic characteristics of uncorrected visual acuity of right eye in the studied 2 groups

OD	Group I	Group II	t test	P value
Mean+ SD.	0.215+0.14	0.16+0.162	0.780	0.455

Table (**3**) shows no statistically difference between Group I and Group II. According to the uncorrected visual acuity of right eye in the studied 2 groups the mean was 0.215±0.14 in Group I and the mean was 0.16±0.162 in Group II no significant difference also between the two groups as the P value was 0.455.

Table (4): Demographic characteristics of uncorrected visual acuity of left eye in the studied 2 groups

OS	Group I	Group II
Mean+ SD.	0.235+0.20	0.210+0.245
T test	.236	
P value	.819	

Table (**4**) shows no statistically difference between Group I and Group II. According to the uncorrected visual acuity of left eye in the studied 2 groups the mean was 0.235±0.20 in Group I and the mean was 0.210±0.245 in Group II no significant difference also between the two groups as the P value was 0.819.

Table (5) Demographic characteristics of contrast sensitivity degree at spatial frequency 1.5

1.5	Group I	Group II
Before	143.4+81.42	163.40+99.05
After	138.6+122.28	208.40+91.135
T test	0.148	1.231
P value	0.885	0.250

The table shows the demographic characteristics of contrast sensitivity degree at spatial frequency 1.5 in the studied 2 groups contrast sensitivity before operation was 143.4±81.42 and one month after operation was 138.6±122.28 in Group I the P value was 0.885. In Group II contrast sensitivity before operation was 163.40±99.05 before operation and was 208.40±91.135 one month after operation groups as the P value was 0.250.

Table (6) Demographic characteristics of contrast sensitivity degree at spatial frequency 3

3	Group I	Group II
Before	288+79.90	317.20+35.417
After	308.80+40.575	308.90+58.41
T test	0.639	0.358
P value	0.539	0.729

The table shows the demographic characteristics of contrast sensitivity degree at spatial frequency 3 in the studied 2 groups contrast sensitivity before operation was 288±79.90 and one month after operation was 308.80±40.575 in Group I the P value was 0.539. In Group II contrast sensitivity before operation was 317.20±35.417 before operation and was 308.90±58.41 one month after operation groups as the P value was 0.729.

Table (7) Demographic characteristics of contrast sensitivity degree at spatial frequency 6

6	Group I	Group II
Before	275.40+86.367	292.20+70.99
After	275.50+79.23	308.9+56.41
T test	0.539	0.359
P value	0.438	0.629

The table shows the demographic characteristics of contrast sensitivity degree at spatial frequency 6 in the studied 2 groups contrast sensitivity before operation was 275.40±86.367 and one month after operation was 275.50±79.23 in Group I the P value was 0.438. In Group II contrast sensitivity before operation was 292.20±70.99 before operation and was 308.9±56.41 one month after operation groups as the P value was 0.629.

Table (8) Demographic characteristics of contrast sensitivity degree at spatial frequency 8

8	Group I	Group II
Before	293.9000+86.00	325.60+26.56
After	275.50+68.80	308.9+40.575
T test	.628	1.500
P value	.545	.168

The table shows the demographic characteristics of contrast sensitivity degree at spatial frequency 8 in the studied 2 groups contrast sensitivity before operation was 293.9000±86.00 and one month after operation was 275.50±68.80 in Group I the P value was 0.545. In Group II contrast sensitivity before operation was 325.60±26.56 before operation and was 308.9±40.575 one month after operation groups as the P value was 0.168.

Table (9) Demographic characteristics of contrast sensitivity degree at spatial frequency 12

12	Group I	Group II
After	325.60+26.563	325.60+26.56
Before	246.2+113.11233	280.0+129.26755
T test	2.041	1.878
P value	.072	.093

The table shows the demographic characteristics of contrast sensitivity degree at spatial frequency 12 in the studied 2 groups contrast sensitivity before operation was 325.60±26.563 and one month after operation was 246.2±113.11233 in Group I the P value was 0.072. In Group II contrast sensitivity before operation was 325.60±26.56 before operation and was 280.0±129.26755 one month after operation groups as the P value was 0.093.

Table (10): Demographic characteristics of contrast sensitivity degree at spatial frequency 18

18	Group I	Group II
Before	247.10+129.268	235+26.563
After	246.20+113.112	317.30+52.81004
T test	0.025	0.425
P value	0.981	0.681

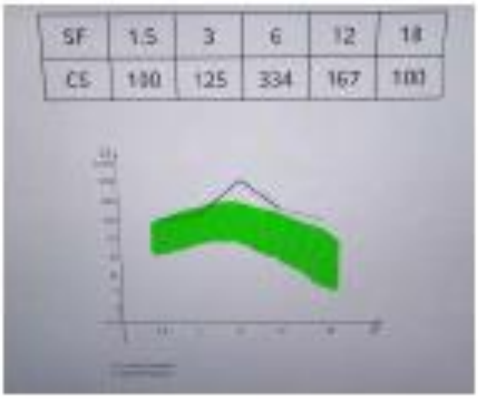
The table shows the demographic characteristics of contrast sensitivity degree at spatial frequency 12 in the studied 2 groups contrast sensitivity before operation was 247.10±129.268 and one month after operation was 246.20±113.112 in Group I the P value was 0.981. In Group II contrast sensitivity before operation was 235±26.563 before operation and was 317.30±52.81004 one month after operation groups as the P value was 0.681

CASES

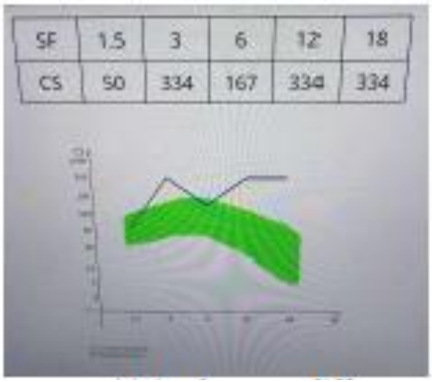
Group I

Case No.1

	SPH	CYL	AXIS	UCVA	BCVA
OD	**-6.5**	**-**	**-**	**0.1**	**1.0**
OS	**-6.5**	**-**	**-**	**0.1**	**1.0**



Assessment of contrast sensitivity degree at different spatial frequencies before operation

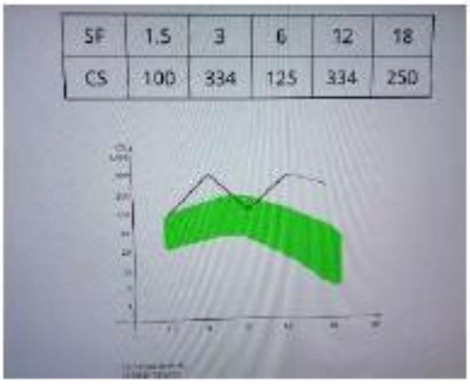


Assessment of contrast sensitivity degree at different spatial frequencies one month after operation

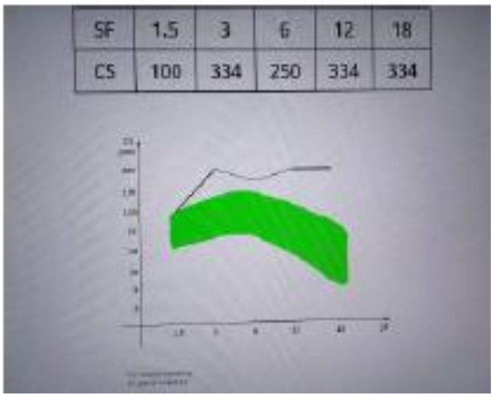
Group I

Case No 2.

	SPH	CYL	AXIS	UCVA	BCVA
OD	**-**	**-3.25**	**80**	**0.3**	**1.0**
OS	**-0.5**	**-0.75**	**90**	**0.7**	**1.0**



Assessment of contrast sensitivity degree at different spatial frequencies before operation

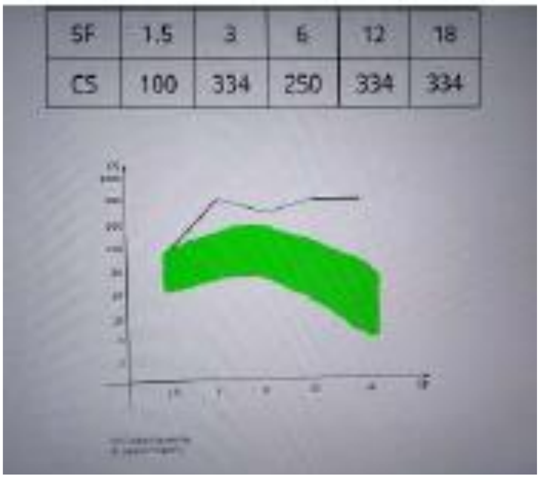


Assessment of contrast sensitivity degree at different spatial frequencies one month after operation

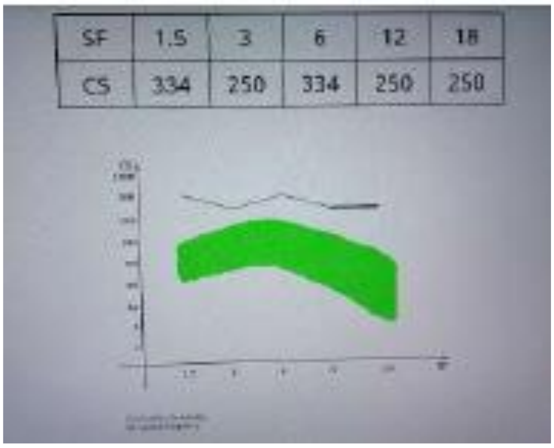
Group I

Case No 3.

	SPH	CYL	AXIS	UCVA	BCVA
OD	**-1.00**	**-0.75**	**170**	**0.4**	**1.0**
OS	**-1.5**	**-1.00**	**10**	**0.4**	**1.0**



Assessment of contrast sensitivity degree at different spatial frequencies before operation

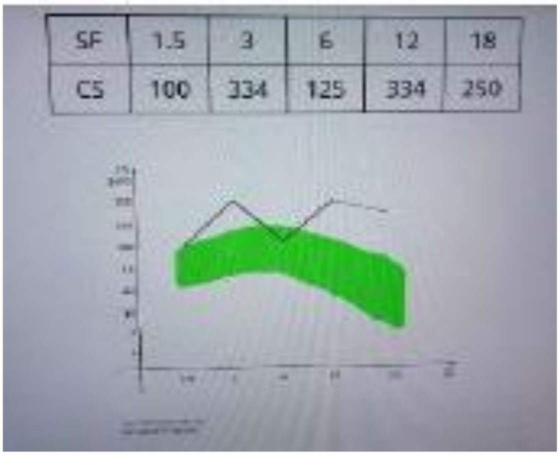


Assessment of contrast sensitivity degree at different spatial frequencies one month after operation

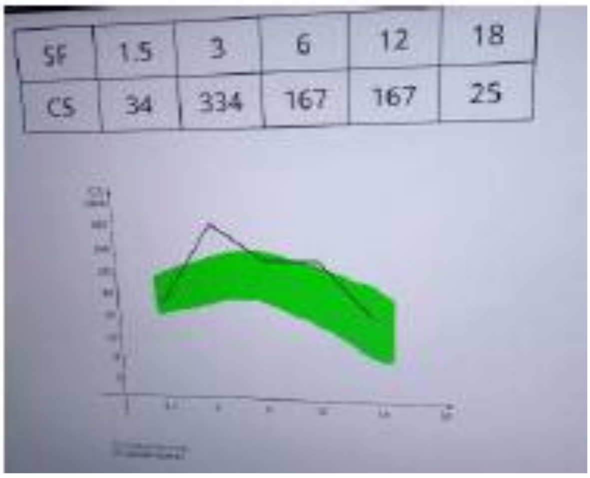
Group I

Case No 4.

	SPH	CYL	AXIS	UCVA	BCVA
OD	**-3.00**	**-0.75**	**90**	**0.2**	**1.0**
OS	**-2.00**	**-1.00**	**80**	**0.3**	**1.0**



Assessment of contrast sensitivity degree at different spatial frequencies before operation

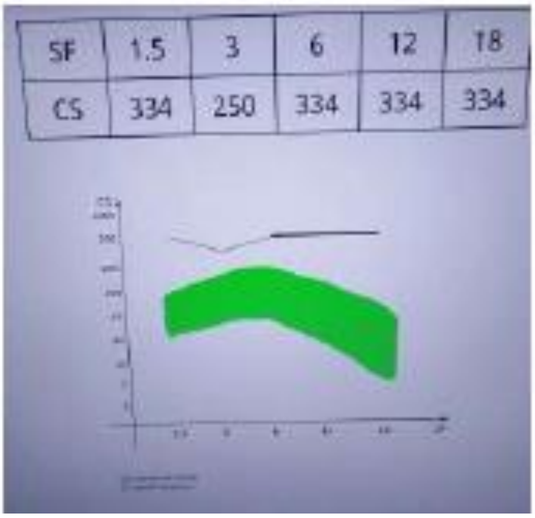


Assessment of contrast sensitivity degree at different spatial frequencies one month after operation.

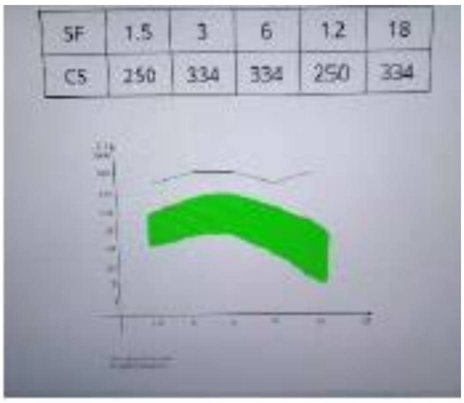
Group I

Case No 5.

	SPH	CYL	AXIS	UCVA	BCVA
OD	**-1.5**	**-1.00**	**95**	**0.15**	**1.0**
OS	**-2.5**	**-0.5**	**25**	**0.1**	**1.0**



Assessment of contrast sensitivity degree at different spatial frequencies before operation

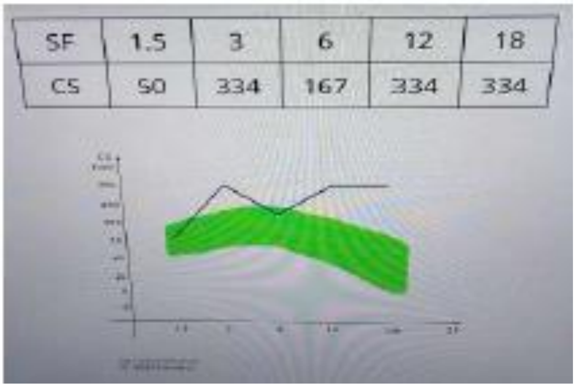


Assessment of contrast sensitivity degree at different spatial frequencies one month after operation.

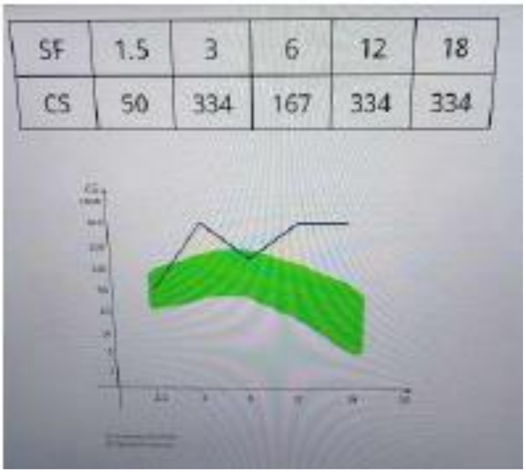
Group 2

Case No 1.

	SPH	CYL	AXIS	UCVA	BCVA
OD	-2.5	-0.25	45	0.05	0.8
OS	-7.00	-0.25	75	0.05	1.0



Assessment of contrast sensitivity degree at different spatial frequencies before operation

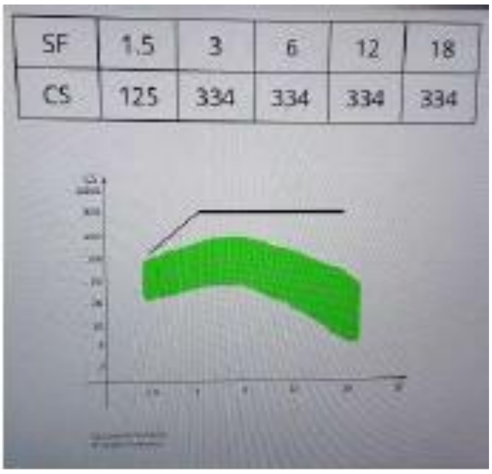


Assessment of contrast sensitivity degree at different spatial frequencies one month after operation

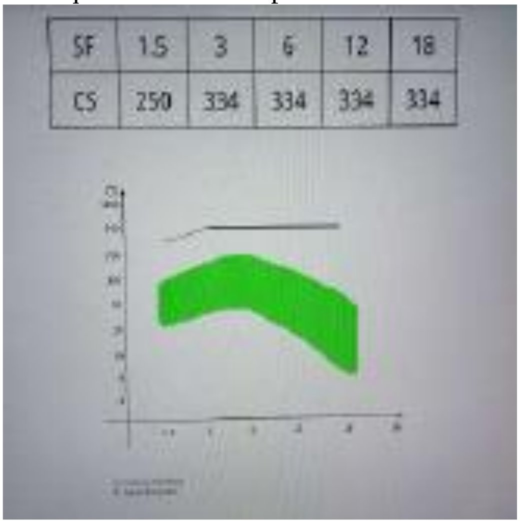
Group 2

Case No 2.

	SPH	CYL	AXIS	UCVA	BCVA
OD	-5.5	-2.00	175	0.1	1.0
OS	-6.5	-1.25	180	0.1	1.0



Assessment of contrast sensitivity degree at different spatial frequencies before operation

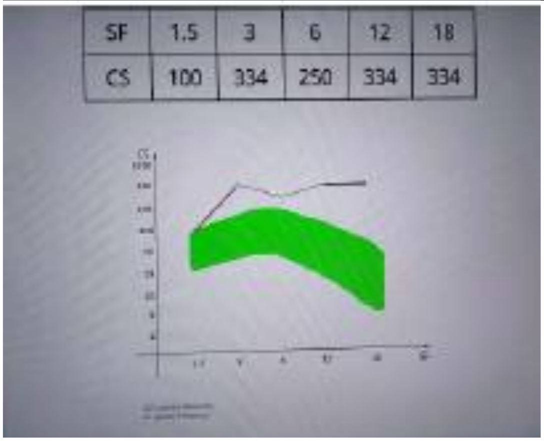


Assessment of contrast sensitivity degree at different spatial frequencies one month after operation

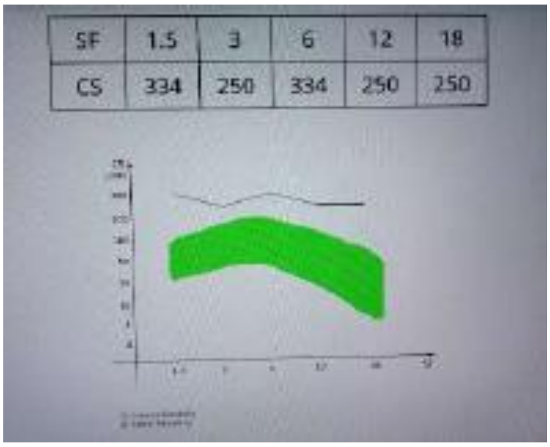
Group 2

Case No 3.

	SPH	CYL	AXIS	UCVA	BCVA
OD	-7.00	-1.25	45	0.1	0.9
OS	-6.5	-1.00	140	0.1	0.9



Assessment of contrast sensitivity degree at different spatial frequencies before operation

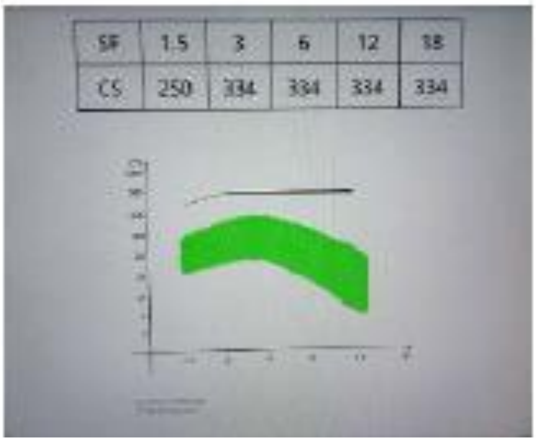


Assessment of contrast sensitivity degree at different spatial frequencies one month after operation

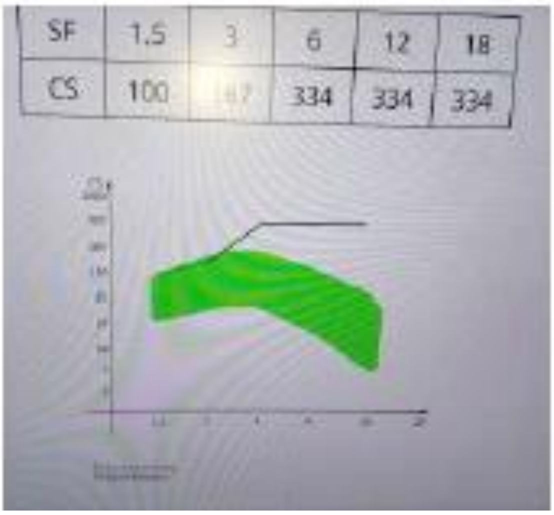
Group 2

Case No 4.

	SPH	CYL	AXIS	UCVA	BCVA
OD	**-6.00**	**-0.75**	**20**	**0.1**	**1.0**
OS	**-6.25**	**-**	**-**	**0.1**	**1.0**



Assessment of contrast sensitivity degree at different spatial frequencies before operation

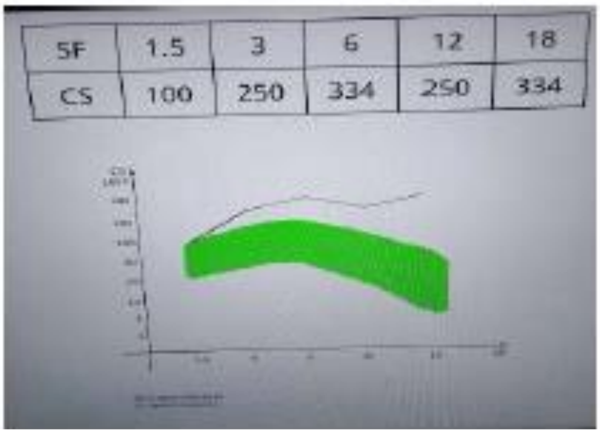


Assessment of contrast sensitivity degree at different spatial frequencies one month after operation

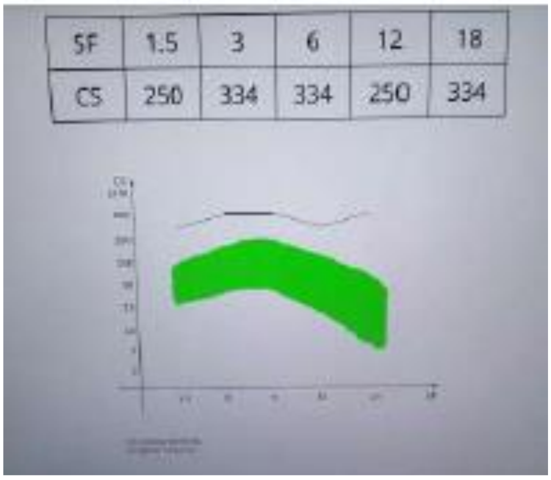
Group 2

Case No 5.

	SPH	CYL	AXIS	UCVA	BCVA
OD	**-7.5**	**-0.5**	**175**	**0.05**	**0.7**
OS	**-5.00**	**-2.00**	**165**	**0.05**	**0.6**



Assessment of contrast sensitivity degree at different spatial frequencies before operation



Assessment of contrast sensitivity degree at different spatial frequencies one month after operation

After doing FACT to 10 cases which divided into two groups we found that:

1- Group 1 that had **PRK** contrast sensitivity was affected worthy after one month.

2- Group2that had **femto SMILE** contrast sensitivity was affected better than group 1 after one month.

3-Contrast sensitivity was affected in both groups but it is more stable after **femto SMILE**

DISCUSSION

In our study we discuss contrast sensitivity affection before and after one month after PRK and femto SMILE.

Twenty cases were collected and divided into two groups: 1st group had PRK, 2nd group had femto SMILE.

All the selected patients was submitted to full ophthalmological examination (visual acuity, fundus examination, pantacam, and assess contrast sensitivity degree before operation and one month after refractive surgery by Function Acuity Contrast Test (FACT).

We found that contrast sensitivity was affected one month after refractive surgery in both groups but it is affected in group 1 after PRK more than group 2 that had femto SMILE.

There are other studies that discuss contrast sensitivity affection before and after different types of refractive surgery as **Robert and Neilcorman[(8)]** study in 2001. In their study, contrast sensitivity at 1.5, 3, 6, 12, and 18 c/deg was measured with the Sterio Optical FACT chart. Results showed a statistically significant reduction in contrast sensitivity at all spatial frequencies in all patients during the first and third month, but contrast sensitivity recovered to preoperative values by six months after surgery. Finally they found that contrast sensitivity measurements specially at 6,12 c/deg was affected after one and three months after LASIK[8].

In **Chan[7] study in 2002** (Contrast Sensitivity Affection After Laser In Situ keratomileusis), the purpose of this study is to determine whether contrast sensitivity measurement, a more sensitive test of visual function than visual acuity. There was a general depression in the contrast sensitivity function after LASIK, 1.5 cpd and 3.4 cpd were the most affected frequencies. Recovery took at least 6 months. The reduction in contrast sensitivity was greater for higher amounts of myopia. They concluded that contrast sensitivity decreased after LASIK probably due to optical factors[7].

In **Nakamura[9]** study in 2001, the purpose of this study is to evaluate the changes in contrast visual acuity based on the amounts of myopic correction with LASIK. In this prospective study, patients with myopia ranging from -2.0 to -14.0 diopters (D) were divided into 2 groups: those with myopia less than -6.0 D and those with myopia greater than -6.0 D. the contrast visual acuity was measured preoperatively and 1 weak and 1 and 3 months postoperatively. The patients with less than -6.0 D of myopia had a contrast visual acuity decrease of 15% 1 weak postoperatively, which recovered by 1 month, and a decrease of 2.5% 1 month postoperatively, which recovered by 3 months. The patients with more than -6.0 D of myopia had a contrast visual acuity decrease at all postoperative times. Finally he concluded that patients with more than -6.0 D of myopia had a persistent decrease in contrast visual acuity. Patients should be informed preoperatively of this possible decrease in contrast visual acuity[9].

Other study by **Liu *et al.*** [10]; contrast sensitivity was depressed at all frequencies one month after LASIK. Myopic eyes between -6.25 D and -14.0 D, and astigmatic eyes 2 DC and more, suffered more static and dynamic contrast sensitivity depression than the myopic eyes between -1.25 D and -6.00 D and astigmatic eyes less than -2 DC. Contrast sensitivities were improved and may be exceed preoperative levels three months after LASIK, and improved even more six months after LASIK. Finally he concluded that there is tempoary depression of contrast sensitivity for myopic eyes after LASIK, which return to exceed preoperative levels at three months after refractive surgery[10].

After comparing our results with other studies results we agree together that contrast sensitivity will be affected in different types of refractive surgery, but our study approved that contrast sensitivity will decrease more after PRK than femto SMILE one month after operation.

CONCLUSION

Contrast sensitivity was affected in both patients who had PRK or Femto SMILE after one month from operation but it is more stable after Femto SMILE.

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