

**CONTRAST SENSITIVITY CHANGES AFTER LASIK AND PHAKIC IOLS IN  
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**ABSTRACT**

**BACKGROUND:** LASIK; a laser in situ keratomileusis is one of the most frequently performed ophthalmic procedures world-wide. The aim of the present study is To compare the postoperative contrast sensitivity function between LASIK, posterior chamber phakic IOL (ICL) and iris-fixated anterior chamber phakic IOL (phakic Iris Claw) surgeries in moderate to high myopic eyes. **METHODS:** A prospective randomized comparative study on 37 patients (60 eyes) with moderate to high myopia. The patients were divided into 3 groups: Group A; included twenty eyes of fifteen patients that underwent LASIK. Minimum corneal thickness is 500 µm. Group B: included twenty eyes of eleven patients underwent ICL implantation, horizontal White to white diameter is 11mm or more. Group C: included twenty eyes of eleven patients underwent phakic Iris Claw implantation, anterior chamber depth (ACD) 2.8 or more. Assessment of visual acuity (uncorrected and best corrected) and contrast sensitivity function using Vistech contrast sensitivity chart were done for all groups preoperatively and after one month and three months postoperatively. **RESULTS:** After one month postoperatively the VA both UCVA and BCVA were greatly improved with correction of refraction in all groups. The contrast sensitivity functions significantly improved at all spatial frequencies (1.5, 3, 6, 12, and 18 cycle per degree [c/d]) in phakic Iris Claw group. It improved in ICL group but did not reach significant levels. LASIK group showed contrast sensitivity improvement at (1.5, 3, 6 and 12c/d) that reach significant value at (3&12 c/d) slight depression was observed at spatial frequency 18 c/d. After three months postoperatively, more improvement in CS thresholds were found in all surgery groups. The LASIK group showed normalization of CS threshold at spatial frequency 18 c/d. **CONCLUSION:** the study affirms the better contrast results after refractive surgery. Three months after LASIK, ICL and iris claw surgeries are enough time for recovery of contrast sensitivity. Phakic iris claw and ICL are valuable surgical correction especially with high refractive errors.

**KEYWORDS:** Contrast sensitivity, LASIK, ICL, Phakic iris claw, myopia, refractive surgery.**INTRODUCTION**

LASIK; a laser in situ keratomileusis is one of the most frequently performed ophthalmic procedures world-wide. It facilitates a broad range for correction of myopia, hyperopia, and astigmatism while avoiding many disadvantages of previous forms of corneal subtraction surgery.<sup>[1]</sup> Phakic intraocular lenses (pIOLs) are indicated for patients with high refractive errors when the usual laser options for surgical correction are contraindicated.<sup>[2]</sup> Phakic IOLs demonstrate reversibility, high optical quality, and potential gain in visual acuity in myopic patients due to retinal magnification; also they are not limited by corneal thickness or topography.<sup>[3]</sup> The drawbacks of pIOLs are rare and related to pIOL position

and type. The main complications of iris-fixated anterior chamber pIOLs are: acute and recurrent subchronic iritis, ischemic atrophy of the iris, pupil distortion, progressive endothelial cell loss, secondary glaucoma, alteration of the blood/aqueous barrier with persistent aqueous flare, dislocation of pIOL and cystoids macular edema.<sup>[4]</sup>

Corneal refractive surgeries are known to change the optical quality of the eye by modifying corneal curvature, therefore, increasing aberrations, diffractions, and light scatter in the optical system.<sup>[5]</sup> These changes may cause reduction in the contrast sensitivity causing night vision disturbances which distress patients during the postoperative period.<sup>[6]</sup>

Visual acuity is the main index used to assess the effectiveness of a refractive procedure.<sup>[7]</sup> However measurement of contrast sensitivity (CS) thresholds for a range of spatial frequencies - contrast sensitivity function- has the ability to detect visual abnormalities in subjects with normal visual acuity but complaining of visual disturbances. The measurement of luminance contrast sensitivity function (CSF) enables a wide spectrum of the spatial visual performance to be estimated, while visual acuity tests usually determines only one extreme point of the function.<sup>[8]</sup> Therefore the use of luminance stimuli to measure contrast sensitivity thresholds is a valuable tool for testing the quality of vision after refractive surgeries.<sup>[9]</sup> Therefore, this study is aiming to compare contrast sensitivity function after LASIK, ICL and phakic Iris claw surgeries in moderate to high myopia.

### PATIENTS AND METHODS

This study was a prospective randomized comparative study on 37 patients (60 eyes), with moderate to high myopia. 24 males and 13 females. The age ranged from 18 to 42. The study was approved by the Ethics Committee of the research Institute of ophthalmology. All participants provided informed consent.

Patients were myopic 5.00 diopters or more, with stable refraction in past year and no history of refractive or any ocular surgery. All patients were subjected to preoperative complete ophthalmic examination to exclude abnormal cornea, Anterior segment pathology (such as cataract, pseudoexfoliations, pigment dispersion and severe iris atrophy, presence of anterior/posterior synechiae, glaucoma or IOP greater than 21 mmHg), or posterior segment pathology (such as retinal detachment, diabetic retinopathy, preexisting macular degeneration or macular pathology). Post operative ophthalmic examinations were done to follow and detect any post operative complications.

The patients were divided into 3 groups: Group A: included twenty eyes of fifteen patients that underwent LASIK. Male to female ratio was 6:9, the age of patients at the time of surgery ranged from 19 years to 41 years, minimum corneal thickness is 500  $\mu$ m. Group B: included twenty eyes of eleven patients underwent ICL implantation. Male to female ratio was 4:7. The age of patients at the time of surgery was ranging from 18 to 30 years, horizontal White to white diameter was 11mm or more. Group C: included twenty eyes of eleven patients underwent phakic Iris Claw implantation. Male to female ratio was 3:8. The age of these patients at the time of surgery was ranging from 19 to 42 years anterior chamber depth is 2.8 mm or more.

Assessment of visual acuity (uncorrected and best corrected) and contrast sensitivity (using Vistech contrast sensitivity chart) were done for all groups preoperative and after one month and three months postoperative.

### Surgical Techniques

For group A (LASIK): cases were done under topical anesthesia by Benoxinate hydrochloride 0.4%. The face was cleaned with a surgical scrub and surgical clothes applied, the cornea was marked with a corneal marker. Next, the pneumatic fixation ring was placed with the eyeball as exposed as possible. The corneal surface has to be lubricated with BSS. An 8.5 to 9.5mm diameter, 90 $\mu$ m-130 $\mu$ m thick, anterior corneal flap was created using the microkeratome.<sup>[10]</sup> The exposed corneal stroma was dried with a piece of sponge, and the laser was refocused and the ablation was started according to the previous calculations introduced earlier into the computer, flap then gently laid back onto the eye, the interface was irrigated with BSS and the borders dried with air or sponge.

For group B (ICL): The pupil should be fully dilated to implant the ICL in the ciliary sulcus. The ICL was loaded with dome up in the cartridge; the loaded cartridge was inserted into the injector and locked into place. Two Paracentesis made by MVR 20G were performed at 12 o'clock and 6 o'clock, the AC is filled with a dispersive (Hydroxypropyl methyl cellulose 1.4%) or a cohesive low-viscous OVD. A clear corneal tunnel incision was done by an angled keratome 3.2mm centered temporal, the cartridge was inserted bevel down, and the ICL injected carefully and slowly using the MicroSTAAR injector. Finally, the haptics were gently pushed under the iris with a blunt spatula.

For group C: Two vertical paracentesis made by MVR 20G directed toward the enclavation area are performed at 2 o'clock and 10 o'clock, the pupil was constricted by injecting acetylcholine (Miochol) in the AC. The AC was filled with a cohesive OVD (Healon GV, Sodium hyaluronate 1.4%) injected through the side port to fully inflate the AC. A clear corneal tunnel incision was done by an angled keratome 3.2mm centered at 12 o'clock. Loading of foldable iris claw lens this done using a specially designed spatula, the lens was then inserted into the AC through the keratome incision and then rotated 90° into a horizontal position, the IOL was fixated with an enclavation needle. A peripheral iridectomy should be performed to prevent pupillary block by a scissor or using a vitrectomy probe, removal of the OVD from the AC was done followed by stromal hydration of the wound.

**Contrast sensitivity test:** Contrast sensitivity thresholds were evaluated by using Vistech Contrast Sensitivity Test System (VCTS). The chart contains five rows and nine columns of circular photographic plates on a grey background. Each plate contains a sine wave grating. Each row has a different spatial frequency (1.5 to 18 cycles per degree) and the contrast within each row reduces from left to right. The gratings are presented in three orientations: vertical (90°), 15° left, or 15° right. The chart was placed near eye level on the wall in an area where it receives uniform lighting and at a 10- feet ( $\pm$ 1 ft)

distance from the patient. Testing was monocular and with correction, the patient was asked to begin with row A and look across from left to right identifying the last patch in which lines can be seen and tell you which direction they tilt. Each vertical column of numbers on the evaluation form corresponds to a horizontal row on the chart. The last patch the patient correctly identifies in each row was recorded by marking the corresponding dot on the evaluation form. The two color pen may be used to distinguish between the right and left eye.

**Statistical analysis:** The data were presented as mean, standard deviations and ranges. The comparison between more than two groups was done by using One Way ANOVA t-test followed by post hoc analysis. The comparison between two independent groups was done by using Chi-square test. The comparison between two paired groups was done by using paired t-test. For these estimations (IBM SPSS) software version 23 was used.

## RESULTS

The pre- and postoperative data in regards to visual acuity (VA), refraction and intraocular pressure (IOP) are summarized in table 1. After one month postoperatively the VA both uncorrected VA (UCVA) and best corrected (BCVA) were greatly improved with correction of refraction in all groups this was continued after three

months follow up. High significant differences were found when compared postoperative UCVA, BCVA mean values with the preoperative values ( $P=0.000$ ).

After 3 months follow up, 19 eyes (95%) in group A had an UCVA 6/12 (0.5) or better, 16 eyes (80%) in group B had an UCVA of 6/12 (0.5) or better, in group C 20 eyes (100%) had an UCVA of 6/12 (0.5) or better. Regarding final refraction; in group A 13 eyes (65%) were within  $\pm 1D$ , 6 eyes (30%) were within  $\pm 2D$ , 1 eye (5%) was more than  $-2.00D$ . In group B 6 eyes (30%) were within  $\pm 0.1D$ , 10 eyes (50%) were within  $\pm 2.00D$  and 4 eyes (20%) were more than  $-2.00D$ . The refractive results were stable and the BCVA improved one to two lines from the preoperative values. In group C, 5 eyes (25%) were within  $\pm 0.1D$ , 10 eyes (50%) were within  $\pm 2.00D$  and 5 eyes (25%) were more than  $-2.00D$ .

During the follow up period, one eye (5%) in Group B (ICL group) had developed increased IOP in the 1<sup>st</sup> week postoperative (IOP 30mmHg); IOP was normalized within two days after use of anti-glaucoma eye drops. Also in Group C (Iris claw group) two eyes (10%) had developed increased IOP in the 1<sup>st</sup> week postoperative normalized by use of anti-glaucoma eye drops. No increase of IOP had occurred in Group A (LASIK group).

**Table 1: Comparison between preoperative and post operative 1 month and 3 months regarding UCVA, BCVA, Refraction and IOP mean values in LASIK, ICL and Phakic Iris claw groups.**

	LASIK			ICL			Phakic Iris claw		
	Pre operative	Post operative 1 month	Post operative 3 month	Pre operative	Post operative 1 month	Post operative 3 month	Pre operative	Post operative 1 month	Post operative 3 month
UCVA	0.11 $\pm$ 0.11 0.02 - 0.4	0.71 $\pm$ 0.18* 0.2 - 0.9	0.76 $\pm$ 0.2* 0.2 - 1	0.09 $\pm$ 0.11 0.02 - 0.5	0.52 $\pm$ 0.22* 0.3 - 1	0.55 $\pm$ 0.23* 0.3 - 1	0.08 $\pm$ 0.07 0.02 - 0.3	0.59 $\pm$ 0.13* 0.3 - 0.8	0.6 $\pm$ 0.15* 0.4 - 0.9
BCVA	0.62 $\pm$ 0.18 0.3 - 0.9	0.72 $\pm$ 0.18* 0.2 - 0.9	0.8 $\pm$ 0.18* 0.4 - 1	0.45 $\pm$ 0.21 0.2 - 1	0.6 $\pm$ 0.22* 0.3 - 1	0.68 $\pm$ 0.21* 0.4 - 1	0.54 $\pm$ 0.18 0.3 - 0.8	0.69 $\pm$ 0.14* 0.3 - 0.9	0.73 $\pm$ 0.12* 0.5 - 1
Refraction	-6.19 $\pm$ 0.88 -8 - -5	-1.08 $\pm$ 0.67* -3 - 0	-1.05 $\pm$ 0.52* -2.25 - -0.25	-15.6 $\pm$ 4.16 -24 - -6.5	-1.76 $\pm$ 1.05* -4 - 0.25	-1.48 $\pm$ 0.8* -3 - 0.25	-13.71 $\pm$ 3.99 -19.5 - -7	-1.41 $\pm$ 1.06* -4 - 0.25	-0.9 $\pm$ 1.5* -4.5 - 2.5
IOP (mmHg)	17.2 $\pm$ 2.82 13 - 23	14 $\pm$ 2.13* 10 - 18	14.05 $\pm$ 2.09* 10 - 18	15.45 $\pm$ 2.63 12 - 19	17 $\pm$ 3.51* 12 - 24	16.1 $\pm$ 3.02 12 - 21	16.45 $\pm$ 1.88 13 - 20	18.15 $\pm$ 3.31 14 - 25	15.6 $\pm$ 2.37 10 - 19

\*: High significant difference at  $P<0.001$  when compare postoperative one month or postoperative 3 months to preoperative value.

### Contrast sensitivity results

In group A (patients underwent LASIK surgery): Post operative measurements after one month showed increase in CS thresholds at all spatial frequencies (1.5, 3, 6, 12 c/d) that reach significant values at 3, 12 c/d ( $P=0.042$ , 0.008) in comparison with

preoperative values while at the highest spatial frequency used; 18 c/d CS threshold slightly decreased. After three months there was more increase in CS threshold value, significant difference was found at 1.5, 3 and 12 c/d spatial frequency (table 2).

**Table 2: Mean ( $\pm$ SD) values of contrast sensitivity preoperative and postoperative after one and three months in group A (LASIK group).**

CST	Pre op	Post op 1m	Post op 3m	P1 value	P2 value	P3 value
	No. = 20	No. = 20	No. = 20			
A(1.5c/d)	4.9 $\pm$ 0.55 4 - 6	5.15 $\pm$ 0.49 4 - 6	5.4 $\pm$ 0.5 5 - 6	0.096	0.008*	0.096
B(3c/d)	5.3 $\pm$ 0.86 4 - 6	5.7 $\pm$ 0.47 5 - 6	5.8 $\pm$ 0.77 5 - 7			
C(6c/d)	4.25 $\pm$ 1.21 3 - 6	4.6 $\pm$ 1.1 3 - 7	4.65 $\pm$ 1.23 2 - 7	0.130	0.119	0.853

D(12c/d)	2.95 ± 1.76	3.95 ± 1.28	3.85 ± 1.23	0.008*	0.044*	0.716
	0 – 6	1 – 6	2 – 6			
E(18c/d)	2 ± 1.69	1.85 ± 1.27	2.45 ± 1.47	0.739	0.415	0.083
	0 – 5	0 – 5	0 – 5			

CST: contrast sensitivity test, Preop: Preoperative, Postop: postoperative, P1: compare postoperative one month to preoperative, P2: compare postoperative 3 months to preoperative, P3: compare postoperative 3 months one month, \*: significant difference at  $P < 0.05$ .

In group B (patients underwent ICL surgery): Post operative measurements after one month, there was some increase in CS thresholds at all spatial frequencies that didn't reach significant values. After three months a

significant increase in CS threshold value, was found at all spatial frequencies in comparison with preoperative values (table 3).

**Table 3: Mean (±SD) values of contrast sensitivity preoperative and postoperative after one and three months in group B (ICL group).**

CST	Pre op	Post op 1m	Post op 3 m	P1 value	P2value	P3 value
	No. = 20	No. = 20	No. = 20			
A (1.5 c/d)	4.85 ± 0.59	5.1 ± 0.72	5.3 ± 0.66	0.171	0.001*	0.297
	4 – 6	4 – 6	4 – 6			
B (3 c/d)	5.2 ± 0.62	5.45 ± 0.69	5.7 ± 0.73	0.056	0.014*	0.096
	4 – 6	4 – 6	5 – 7			
C (6 c/d)	3.35 ± 0.75	3.7 ± 0.86	4.3 ± 1.22	0.069	0.001*	0.007*
	2 – 5	3 – 6	3 – 7			
D (12 c/d)	1.7 ± 1.17	2.15 ± 1.5	2.25 ± 1.25	0.154	0.045*	0.629
	0 – 4	0 – 6	1 – 6			
E (18 c/d)	0.55 ± 0.6	0.95 ± 1	1.3 ± 1.22	0.072	0.012*	0.110
	0 – 2	0 – 3	0 – 5			

CST: contrast sensitivity test, Pre op: Preoperative, Post op: postoperative, P1: compare postoperative one month to preoperative, P2: compare postoperative 3 months to preoperative, P3: compare postoperative 3 months one month, \*: significant difference at  $P < 0.05$ .

In group C (patients underwent iris claw surgery): Post operative measurements after one month showed significant increase in CS threshold values at all spatial frequencies in comparison with preoperative values.

After three months a more significant increase in CS threshold values, was found at all spatial frequencies (table 4).

**Table 4: Mean (±SD) values of contrast sensitivity preoperative and postoperative after one and three months in group C (Iris Claw group).**

CST	Preop	Postop 1m	Postop 3m	P1 value	P2value	P3 value
	No. = 20	No. = 20	No. = 20			
A(1.5c/d)	5.05 ± 0.69	5.4 ± 0.6	5.55 ± 0.51	0.005*	0.004*	0.267
	4 – 6	4 – 6	5 – 6			
B(3c/d)	4.85 ± 1.14	5.45 ± 0.83	5.95 ± 0.69	0.014*	0.000*	0.014*
	2 – 7	3 – 7	5 – 7			
C(6c/d)	3.35 ± 1.18	4.25 ± 1.37	4.6 ± 1.35	0.004*	0.000*	0.273
	1 – 5	2 – 7	3 – 7			
D(12c/d)	1.7 ± 1.08	2.45 ± 1.64	2.85 ± 1.42	0.044*	0.005*	0.305
	0 – 4	0 – 7	1 – 6			
E(18c/d)	0.8 ± 0.89	1.15 ± 1.46	1.3 ± 1.3	0.217*	0.056*	0.481
	0 – 3	0 – 5	0 – 4			

CST: contrast sensitivity test, Pre op: Preoperative, Post op: postoperative, P1: compare postoperative one month to preoperative, P2: compare postoperative 3 months to preoperative, P3: compare postoperative 3 months one month, \*: significant difference at  $P < 0.05$ .

Preoperative contrast sensitivity mean value were significantly higher in group A in comparison with its value in group B and group C at spatial frequency 6, 12 and 18 c/d(table 5). follow up After three months post operative the contrast sensitivity thresholds were still

significantly higher in LASIK group than group B and group C at spatial frequency 12 and 18c/d(table6). (figure1).

**Table 5: Mean ( $\pm$ SD) values of preoperative contrast sensitivity in all groups.**

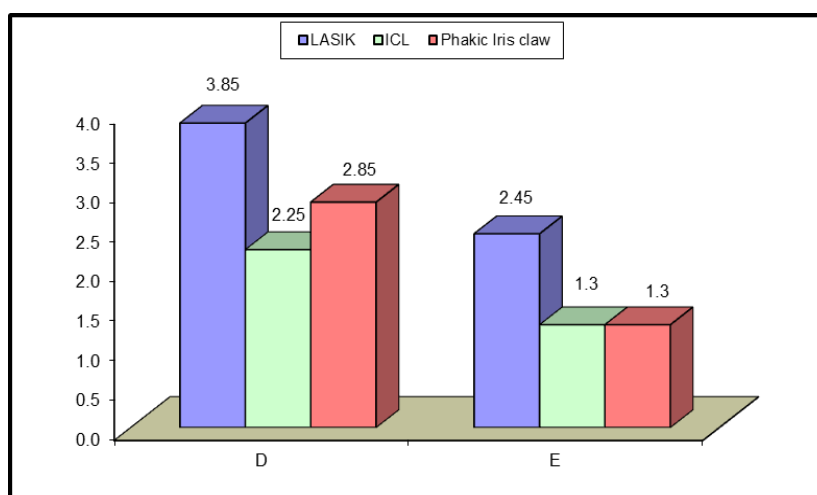
Preoperative Contrast Sensitivity Test	LASIK	ICL	Phakic Iris claw	P1	P2	P3
	No. = 20	No. = 20	No. = 20			
A(1.5c/d)	4.9 $\pm$ 0.55	4.85 $\pm$ 0.59	5.05 $\pm$ 0.69	0.797	0.441	0.305
	4 – 6	4 – 6	4 – 6			
B(3c/d)	5.3 $\pm$ 0.86	5.2 $\pm$ 0.62	4.85 $\pm$ 1.14	0.726	0.119	0.223
	4 – 6	4 – 6	2 – 7			
C(6c/d)	4.25 $\pm$ 1.21	3.35 $\pm$ 0.75	3.35 $\pm$ 1.18	0.010*	0.010*	1.000
	3 – 6	2 – 5	1 – 5			
D(12c/d)	2.95 $\pm$ 1.76	1.7 $\pm$ 1.17	1.7 $\pm$ 1.08	0.006*	0.006*	1.000
	0 – 6	0 – 4	0 – 4			
E(18c/d)	2 $\pm$ 1.69	0.55 $\pm$ 0.6	0.8 $\pm$ 0.89	0.000*	0.002*	0.497
	0 – 5	0 – 2	0 – 3			

P1: compare ICL group to LASIK group, P2: compare phakic iris claw group to LASIK group, P3: compare phakic iris claw group to ICL group, \*: significant difference at  $P < 0.05$ .

**Table 6: Mean ( $\pm$ SD) values of three months postoperative contrast sensitivity in all groups.**

Post operative 3 months C.S T	LASIK	ICL	Phakic Iris claw	P1	P2	P3
	No. = 20	No. = 20	No. = 20			
A(1.5c/d)	5.4 $\pm$ 0.5	5.3 $\pm$ 0.66	5.55 $\pm$ 0.51	0.575	0.401	0.164
	5 – 6	4 – 6	5 – 6			
B(3c/d)	5.8 $\pm$ 0.77	5.7 $\pm$ 0.73	5.95 $\pm$ 0.69	0.666	0.518	0.283
	5 – 7	5 – 7	5 – 7			
C(6c/d)	4.65 $\pm$ 1.23	4.3 $\pm$ 1.22	4.6 $\pm$ 1.35	0.386	0.901	0.457
	2 – 7	3 – 7	3 – 7			
D(12c/d)	3.85 $\pm$ 1.23	2.25 $\pm$ 1.25	2.85 $\pm$ 1.42	0.000*	0.018*	0.151
	2 – 6	1 – 6	1 – 6			
E(18c/d)	2.45 $\pm$ 1.47	1.3 $\pm$ 1.22	1.3 $\pm$ 1.3	0.008*	0.008*	1.000
	0 – 5	0 – 5	0 – 4			

CST: Contrast sensitivity test, P1: compare ICL group to LASIK group, P2: compare phakic iris claw group to LASIK group, P3: compare phakic iris claw group to ICL group, \*: significant difference at  $P < 0.05$ .

**Figure 1: The demographic mean Contrast sensitivity values three months post operative at spatial frequencies 12c/d (D) and 18c/d (E) in all groups.**

## DISCUSSION

Myopia is a common refractive error all over the world. Many methods can be used for correction, in our study we focused on 3 variable lines including LASIK, ICL and phakic Iris claw implantation.

The use of luminance contrast sensitivity test under mesopic condition was chosen in our study. This is

because the use of luminance stimuli to measure contrast sensitivity thresholds is more typical and it has shown to be a valuable tool for testing the quality of vision after refractive surgeries.<sup>[11,9]</sup> Mesopic contrast sensitivity was reported to be more affected by the treatment intervention than photopic contrast sensitivity.<sup>[12]</sup>

In the present study, after one month postoperatively, the contrast sensitivity function significantly improved at all spatial frequencies (1.5, 3, 6, 12, and 18 c/d) after iris claw surgery. It improved in ICL group but did not reach significant levels. LASIK group showed contrast sensitivity improvement at (1.5, 3, 6 and 12c/d) that reach significant value at (3&12 c/d) slight depression was observed at spatial frequency 18 c/d. After three months postoperatively, more improvement in CS thresholds were found in the all surgery groups. The Iris claw group showed more significant increase in CS at all spatial frequencies, as well as the ICL group. The LASIK group showed significant increase at spatial frequencies; 3, 6, 12 c/d and normalization of CS threshold at spatial frequency 18 c/d.

We are assuming that our results are contributed to better CS measurement results after refractive surgeries. After three months postoperatively, no significant depression of contrast sensitivity thresholds was found with the refractive surgeries used (LASIK, Iris Claw and ICL) at any spatial frequency tested. These results are in agreement with a number of studies. Barboni *et al.*,<sup>[8]</sup> found no significant CS depression after 3 months of wave-front guided surgeries. Dick *et al.*<sup>[13]</sup> reported that implantation of the iris-claw lens in phakic eyes to correct high or moderate myopia was shown to increase the mean contrast sensitivity threshold values three months postoperatively at all spatial frequencies compared with preoperative levels. Kaiserman *et al.*,<sup>[14]</sup> measured CS at the same five spatial frequencies we used preoperative and one month after wave-front guided LASIK. They found significantly improved contrast sensitivity at all spatial frequencies one month after surgery. A better mesopic CS was also observed in the WF-LASIK group after three months at spatial frequency of 12c/d.<sup>[15]</sup>

Regarding temporary depression of contrast sensitivity thresholds after LASIK surgery (group A). our results showed shorter time for CS thresholds recovery than previously described. Chan *et al.*,<sup>[16]</sup> determined luminance contrast sensitivity thresholds in conventional LASIK eyes. They found significantly depressed CS thresholds after surgery with a return to normal values after six months. Goyal *et al.*,<sup>[17]</sup> compare visual outcome between wavefront-guided and aspheric LASIK for myopia and myopic astigmatism. The wavefront-guided group showed a slight decrease at higher spatial frequency (18 c/d) that still even at six months postoperatively.

It has been demonstrated that ICL implantation provides better outcomes of visual acuity, and contrast sensitivity than LASIK especially for cases with large refractive errors and pupil sizes. This was reasoned that LASIK producing larger high-order aberrations.<sup>[18]</sup> Nevertheless Chandhrasri *et al.*,<sup>[19]</sup> found that Contrast sensitivity measurement two months after LASIK is normal as well as after the Verisyse IOL implantation.

In the present study preoperative contrast sensitivity values were within normal in all groups and no significant difference between LASIK, ICL and iris claw groups was shown at low spatial frequencies. At high spatial frequencies (12&18c/d) CS thresholds were subnormal in all myopic groups. In LASIK group, preoperative CS was significantly higher than each of ICL and iris claw groups. This was attributed to the degree of myopia<sup>[20]</sup> and corrected visual acuity.<sup>[21]</sup> Myopia causes contrast sensitivity losses at high spatial frequencies. After three months postoperatively, there was a significant increase in CS thresholds in all groups. Each of ICL and iris claw groups that included high myopic subjects still showed significantly lower CS results than that in the LASIK group at high spatial frequencies. This was best observed at 12&18 c/d. (figure: 1) these finding were reasoned that in highly myopic eyes the contrast sensitivity function reduced at higher spatial frequencies. That reduction is in the retinal photoreceptor sensitivity<sup>[22]</sup> and/ or a reduction in the sensitivity of postreceptoral processes.<sup>[23]</sup>

## CONCLUSION

The present study confirms and contributes to the better contrast results after refractive surgery. Three months after refractive surgery; LASIK, ICL and iris claw are enough time for recovery of contrast sensitivity. Phakic iris claw and ICL are valuable surgical correction especially with high refractive errors .

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## CONFLICT OF INTERESTS

The authors declare no conflict of interest.

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