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AN ANALYTICAL STUDY OF BLINK RATE EFFECT ON OPTICAL PERFORMANCE DYNAMICS

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Abstract:

This work aimed to examine the optical quality of tear films(TFs) for four sorts of the silicon hydrogelic contact lens type (SHCL) for everyday wearing for 15 days for various blink rates (BRs). The selected contact lenses in this work involvedlotrafilcon B, samfilcon A, comfilcon A, and filcom V3 brands. Serial estimations of the Objective Scatter Index (OSI) utilizing the HD Analyzer were taken at the distinctive blinking pattern: blinks each 2.5 sec (higher rates) and each 9 sec (lower rates). They were carried out within the firstly visiting before inserting the contact lens, after 20 min of wearing on the 1st-day, and after 8 h of wearing on the 15th-day. Healthy young's eyes were fitted with the mentioned lenses. In case of low BRs, all of the contact lenses mean OSI values and slopes were increased over the time, wile the contact lens D showed an opposite trend. When contact lenses B and C were used, the mean OSI increased and the slope remained constant. Dynamically the visual quality of the TF after wearing the selected lenses for 15 days showed a slight deterioration at lowest BRs levels.

Introduction:

Tear film (TF) is an important component of improving eyesight [1-4]. There have been a few examinations on the impacts of soft contact lenses on the typical visual condition. Tear breaking up times, creation,and vanishing were discovered to be influenced by wearing of contact lenses. Several reports mentioned the coordination role of TF in

contact lens wearers at different periods of time using keratoscopy and the double pass method [5-10]. Until now, the most utilized contact lenses are soft hydrogel or silicone-hydrogel (SH) lenses.The findings demonstrated the substantial diminish in pre-corneal TF content with monthly use contact lenses and the silicon hydrogel contact lens (SHCL)utilization for seven days; daily contact lenses over 4 h of utilization; the daily hydrogelic lenses over 24 h of utilization; PMMA rigid contact lenses and rigid gas permeable [5,6]. During the utilization of hydrogel contact lenses it has likewise been discovered that incendiary conditions, for example, papillary conjunctivitis, intense red eye, and infiltrative keratitis have higher rates than those revealed with SHs.

Novel contact lens compounds are currently focusing on enhancing the TF stability to ensure optimum vision quality. Around the same period, the wide utilization of desktops, notebooks and mobiles, smartphones, computers and devices of electronics nowadays [11].Under these conditions, the risk of eye injury increases due to a decrease in the BR blink rate [12]. Moreover, the contact lens wearer needs to increase their BRs as a result of the corneal surface irritation or the unstability of the TF [13]. Both of these reasons could influence the TF optics and, ultimately, adaptation success of the contact lenses. The High Definition Analyzer (HD AnalyzerTM) utilizes a double-pass system that has been designed to conduct an objective optical quality assessmentoffers an independent scientific measurement of the optical condition of the eye.Evaluation the empirical index of the intraocular (IOL) radiation scattering, namely Objective Scatter Index (OSI) utilizing the optical function, namely point spread function (PSF) that evaluates the retinal image of a point source. It is actually used to determine the eye TF dynamics in either dry or normal eye [14-17].

This work aimed to analyze the BRs influence over 15 days of using four brands of the same kind of contact lenses.

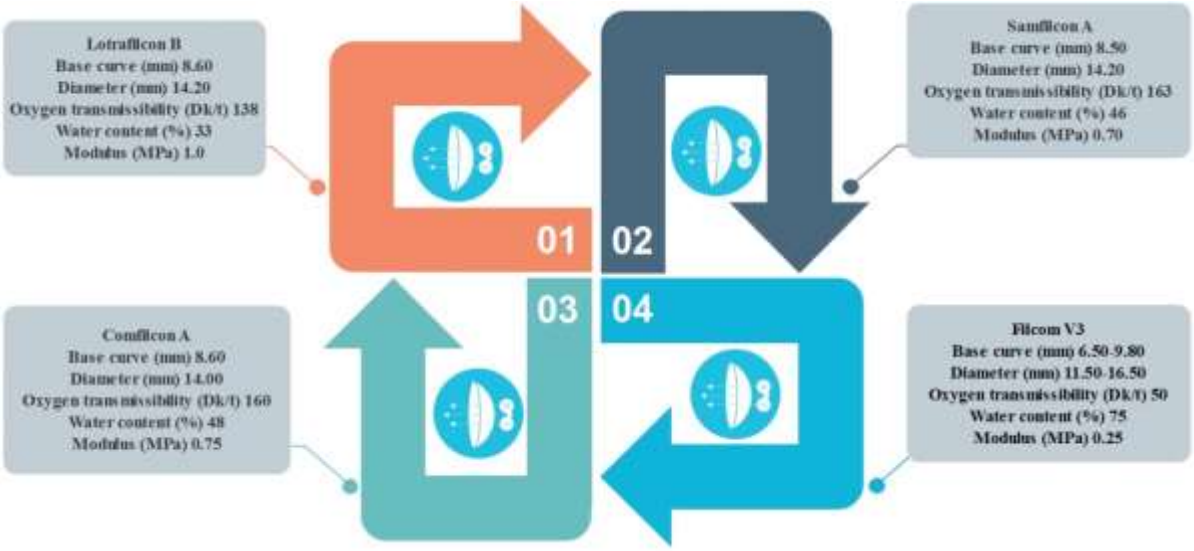
Methods:

Subjects and optical analysis

The participants in this research were totally fifteen participant (12 males + 3 females); their age ranged from 20 to 30 years. Both have been provided informed consent and were subject to the protocol for each step of the research after informing them of the main purpose of the research and its requirements in detail. The refractive errors appeared in this age range were cylinder and spherical errors regardless the power values.In this paper, surgery, active eye allergy, or treatments that affect the TF are excluded. Optical quality was assessed using HD AnalyzerTM (Visiometrics, Iran).By measuring the amount of light incident on the perimeter of the image, OSI values (1 minute of arc) are calculated as opposed to the amount of light incident in the center (12-20 minutes of arc).

To record the OSI values complex changes, TF analysis software is used. The software consisted of a measurement of 20 s every 0.5 s, providing a quantitative and a rational estimate of the visual efficiency loss because of the TF diminish. The HD AnalyzerTM from Visiometrics, Iran device facilitates the tracking of complex variation of optical efficiency. The outcome screens displays all of the images obtained through theprocedure; each one has one OSI score. At the point when the subject blinked, the OSI esteem was supplanted by a blink mark and no worth was enrolled around then.

The spherical refractive errors were quickly amended by the HD Analyzer TM. The OSI dynamics were measured twice separately; the dark adapting tie was 5 min. Two blink designs were set up contingent upon how much allows the subject to blink. They were approached to blink each 2.5 seconds (high BRs) during the entire chronicle measure (20 seconds) and inevitably, they were approached not to blink for 9 seconds (low BRs). Blink speeds were directed by the discernible sign created by the instrument. Until proceeding, enlistment subjects were asked to blink normally twice and afterward keep their eyes open. There was washing-out time season of 10 minutes for the two scales (high and low BRs) as seen in Figure 1. It was completed for five sequential weeks, utilizing 4 types of monthly contact lenses made of silicone hydrogels for daily wearing. The marketed contact lenses are illustrated in Scheme 1 in details.



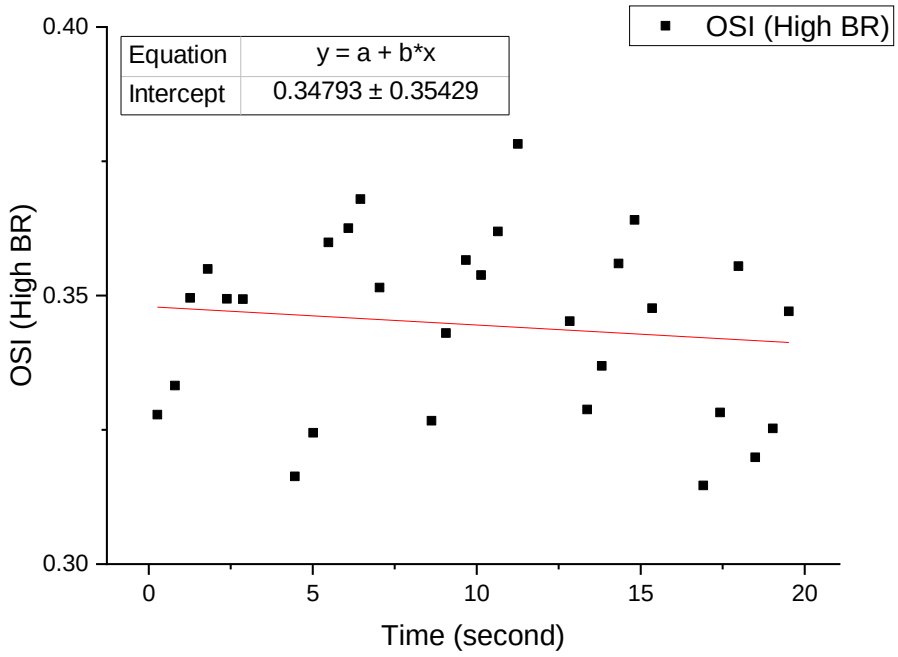
Scheme 1: A scheme of the SHCLs specifications that have been marketed for the study.

Contact lenses were randomly assigned after three weeks of washing out. The research team directed participants for wearing contact lenses for 8 h a day. After that, the researchers conducted a slit lamp evaluation after a week of washing out without a contact lens and after 15 days in the presence of the contact lenses that had been previously assigned. The next step included a measure OSI dynamics at high and low BRs for each contact lens pair at the first day and after 15 days of wearing. Measurements were made on the first day of wear prior to the baseline case of contact lens inserting, at the Day 1 (after 20 min of wearing), and at Day 15 (8 h of wearing).

Statistical analysis

Statistical research was conducted utilizing SAS software version 9.4 from (SAS Institute, Inc., USA). There were 40 OSI value released from HAD for TF analysis.Programmatically, it was recorded an OSI score at each 0.5 second along a period of 20 seconds. All values were evaluated for high-BR scenarios, but only the first 9 seconds were evaluated for low-BR scenarios. Statistical research was carried out using a descriptive analysis to derive mean results and standard deviations. In order to determine the stability of the TF, the regression models and the slopes the curves were

employed to evaluate the OSI-Time relation. As a result, mean and standard deviations for OSI dynamic values and curve slopes were analyzed for each recorded BR situation. A Shapiro–Wilk test was utilized, then, a parametric ANOVA test with the Greenhouse-Geisser revision or non-parametric Friedman test for contrast ($p < 0.05$). The realistic portrayal of OSI esteems for high BRs was recorded over 20 seconds. Progressive spans were enlisted isolated by blinks, and the chart speaks to a strength model of the OSI esteem with a level curve. The realistic portrayal of OSI esteems for low BRs was recorded over 9 seconds, and just a single interval registration and analyze was done. The circulation of OSI esteems over time has various practices: case 1 speaks to a steady model with a level curve, while case 2 speaks to a model of insecurity with an expansion in the incline of the curve. Estimations were performed for each visit (baseline, Day 1, and Day 15) utilizing random assignment of contact lenses.



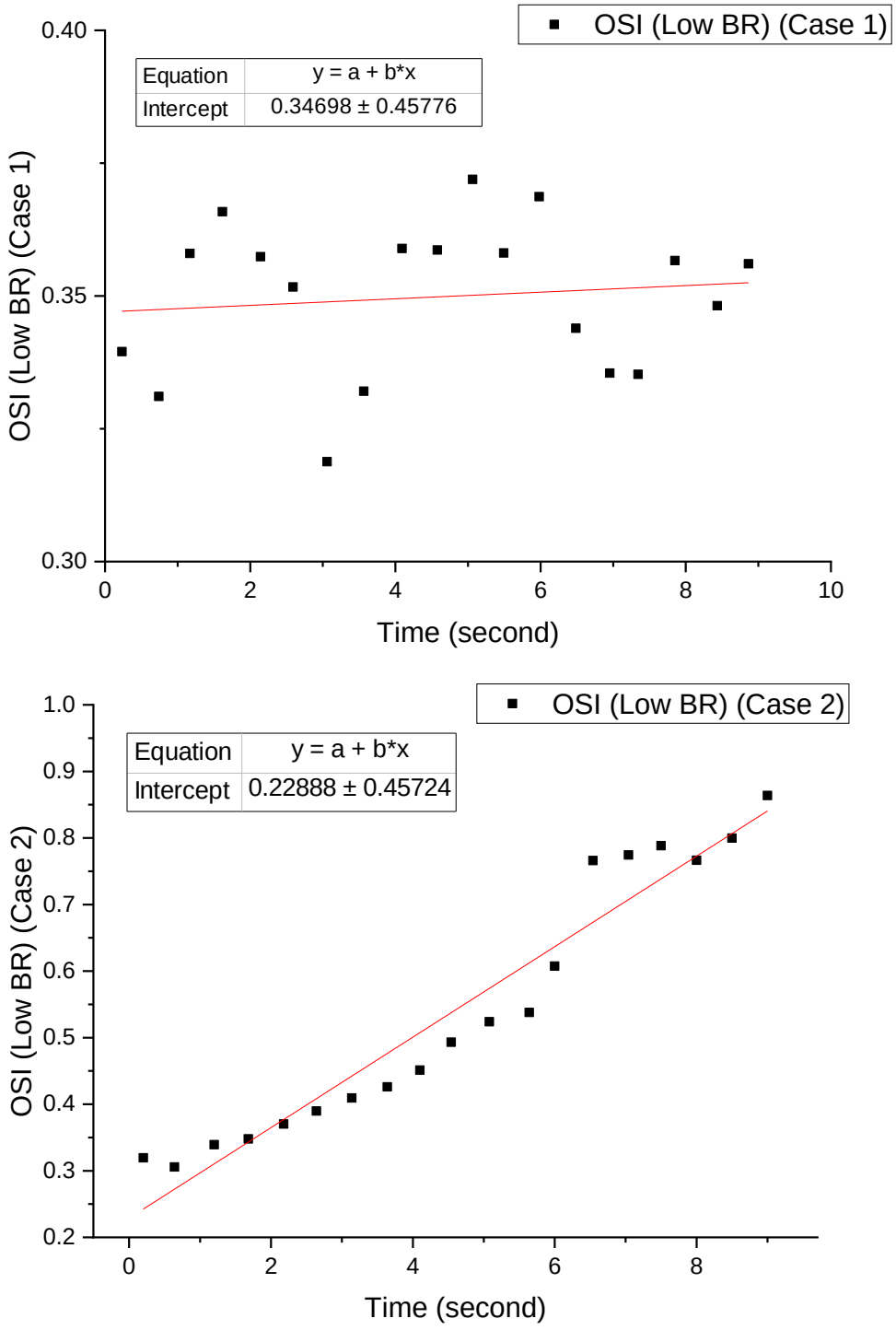


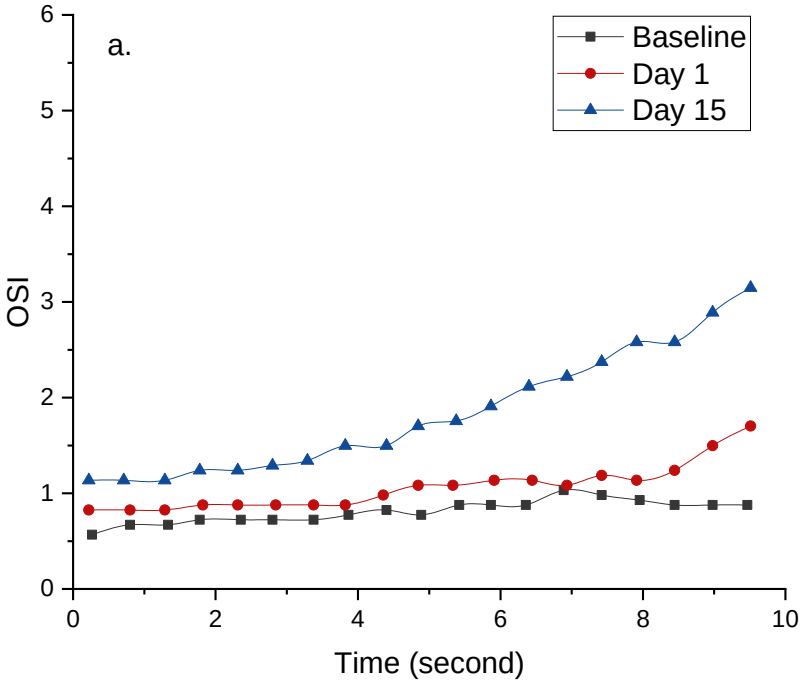
Figure 1: Repeated ANOVA test of OSI at 2.5 seconds of blinking (high BR), and at 9 seconds of non-blinking (low BR).

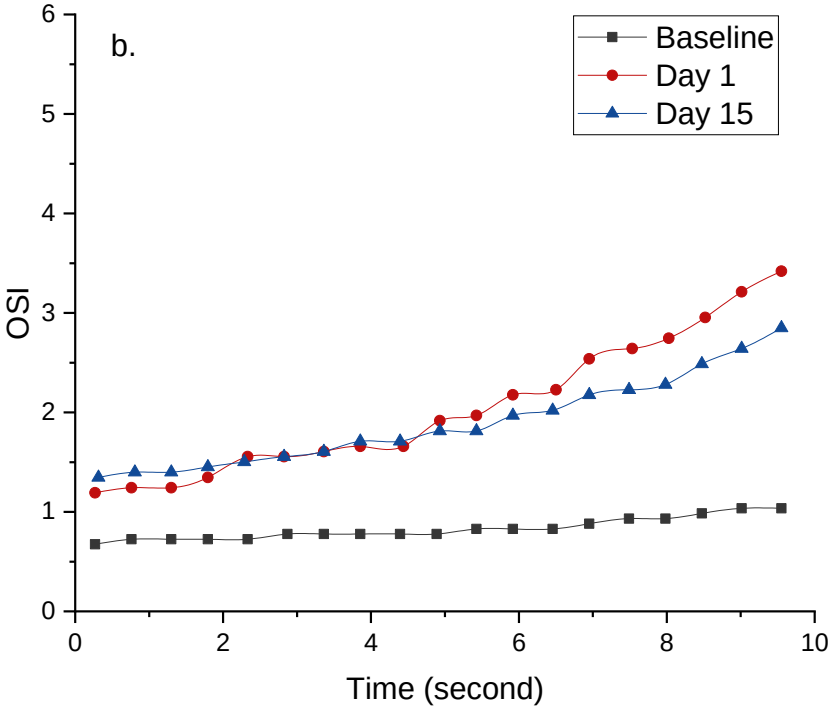
Results and discussion:

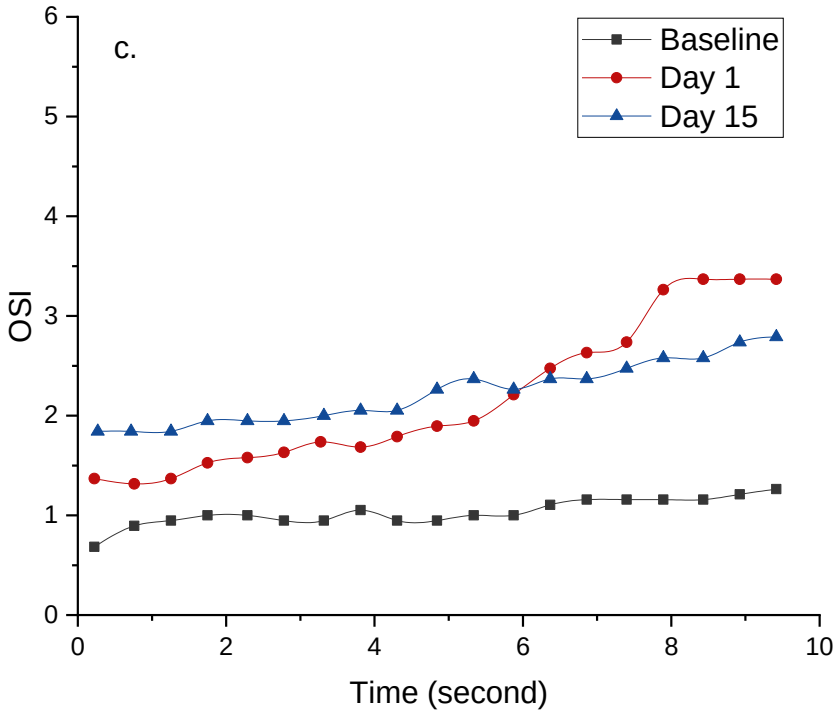
The corneal surface was preserved from any adverse event throughout the study period. The baseline values of BRs OSI case that obtained to be 0.31±0.16 for CL A, 0.46±0.13 for CL B, 0.34±0.08 for CL C, and 0.40±0.13 for CL D (see Table 1). The findings of the repeated-ANOVA tests on baseline, Day 1, and the Day 15 visits demonstratedcontact lens wearing impact on OSI dynamics over a period of time. The mean OSI dynamic value has improved for all contact lenses.The baseline curve slope revealed an error rate ±0.05 when CL A was inserted and 0.04 when CL C was used and no statistical significance has observed (Figure 2 a., b., c., and d.).It is worth noting that under this circumstance, the OSI dynamic value improved on day 15 for all lenses at baseline except for the D lens.

Table 1: Statistical analysis of dynamic OSI for low BRs

		Dyn. OSI			
		CL A	CL B	CL C	CL D
Low BRs (mean±SD)	Baseline	0.83±0.46	0.78±0.25	1.03±0.61	0.67±0.15
	Day 1	1.06±0.62	2.01±2.27	2.15±2.03	1.23±0.62
	Day 15	1.83±1.63	1.87±1.98	2.23±2.44	1.10±0.42
	p-value	0.04	0.03	0.03	0.03
		Slope			
		CL A	CL B	CL C	CL D
Low BRs (mean±SD)	Baseline	0.03±0.05	0.03±0.04	0.04±0.08	0.03±0.05
	Day 1	0.07±0.08	0.24±0.56	0.24±060	0.10±0.18
	Day 15	0.21±0.31	0.15±0.35	0.10±0.12	0.07±0.11
	p-value	0.05	0.05	0.06	0.63


a.
Baseline
Day 1
Day 15
OSI
Time (second)
0
1
2
3
4
5
6
0
2
4
6
8
10


b.
Baseline
Day 1
Day 15
OSI
Time (second)
0
1
2
3
4
5
6
0
2
4
6
8
10


c.
Baseline
Day 1
Day 15
OSI
Time (second)
0
1
2
3
4
5
6
0
2
4
6
8
10

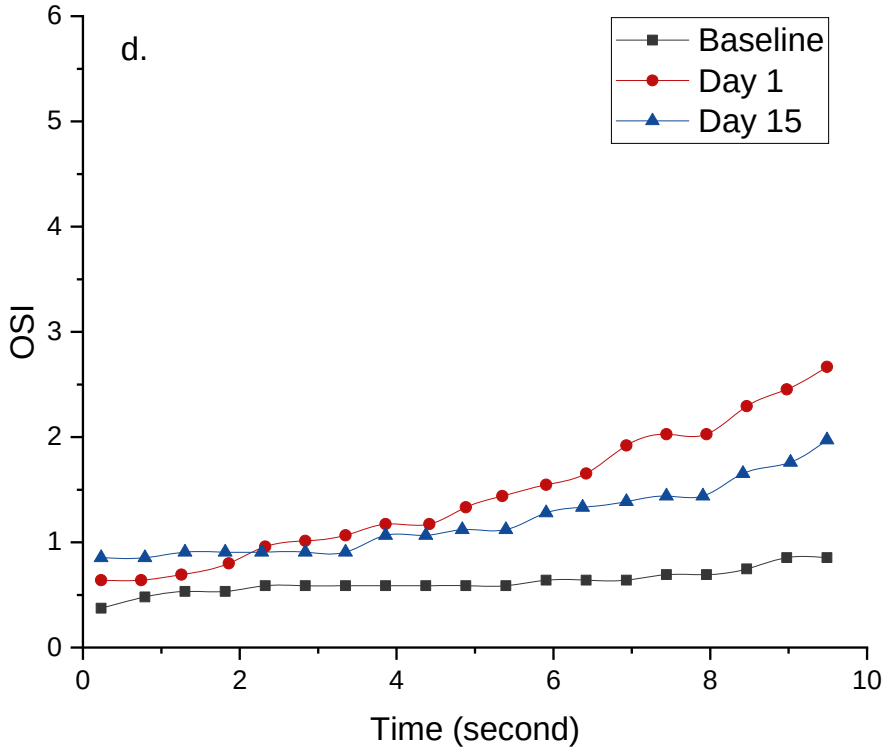


Figure 2: Graphical portrayal of OSI elements for low BRs: (a) CL A. (b) CL B. (c) CL C. (d) CL D.

On the other hand, the OSI of the high BRs case analytic insightsOSI elements are listed in Table 2. For all of the used contact lenses, the optical performance was diminished as a result of the OSI dynamic valuesincreasing over time in spite the statistical variation in B and C lenses ($p< 0.05$). The results of this investigation after the BRs were reduced revealed a deterioration in the reliability of the optical efficiency compared to the results obtained from a high BRs condition. The curve slope remained constant after 15 days in spite of the decrement in TF consistency. From the same table it is easy to notice the shift in OSI values due to the preservation of the reliability of its values in the high BRs.

Table 2: Statistical analysis of dynamic OSI for high BRs.

		CL A	**CL B**	**CL C**	**CL D**
Dyn. OSI (mean±SD)	Baseline	0.66±0.27	0.79±0.22	0.70±0.34	0.64±0.15
	Day 1	0.71±0.20	1.12±0.78	1.07±0.77	0.83±0.45
	Day 15	0.92±0.61	1.14±0.57	1.15±0.76	0.01
	p-value	0.06	0.02	0.01	0.08

Several investigations demonstrated the contact lenses role in the TFand the image quality improvements [18-23]. This may theoretically affect contact lens resistance and

contribute to blurred vision. Novel design ofcontact lenses concentrate on enhancing some of their characteristics to get the required vision correction under the effect of electronics devices [24].The goal of this cross-over pilot investigation was to determine complex improvements in optical efficiency through contact lens wear in a typical group of participants. They were all wearing 4 various styles of the used lenses for fifteen days. The findings of this work are supported by the analysis of previous reports discussed the OSI values [25-27]. Generally, TF is analyzed in terms of consistency and quantities, that are key variables in theTF characterization dynamic [28]. In these investigations, film stability factors are determined on the basis of OSI dynamics. For several various forms of contact lenses, and even more so for low BRs. By changing the susceptibility of the prelensTF, it is possible to preserve the refractive surface of the contact lens smoothly. In particular, OSI scores were enhanced for CL B and CL C in spite of the dramatically indication for low BRs in comparison with high BRs [29,30]. Under all BRs cases, everyparticipant recorded a stabilized optical performance under baseline condition (OSI dynamic recorded < 1 values).

Conclusion:

Improving the wettability of the contact lenses by increasing the surface and polar energies increase the consistency of the surface of the TF, which leads to improved vision correction for aberrated eyes.The parameters in this work demonstrate that the OSI dynamics scores changed between baseline conditions and wearing of SHCL, and the blink rates effect on the shapes of the curves. From the obtained findings, one can conclude that the selected contact lenses have disrupted the TFs while increasing OSI scores. This work focused on the advantages of the contact lenses in terms of moisturizing, dehydration, antimicrobial surface treating, and elastic modulus, to prove the best vision, which is defined as the stability of the retinal image quality in the contact lenses presence between blinks over time.

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