(6) A COMPARATIVE STUDY OF THE STATUS OF BINOCULAR VISION AND ACCOMODATION WITH SPECTACLES AND CONTACT LENSES IN MYOPES.

Dr. Parul M. Danayak, Dr. Nitin Trivedi, Dr. Kamini Sanghvi, Dr. Atanu Samanta, Dr. Aesha Patel

Dr. Parul M. Danayak (Assistant Professor), **Dr. Nitin Trivedi** (Professor), **Dr. Kamini Sanghvi** (Superintendent), **Dr. Atanu Samanta** (Optometrist) and **Dr. Aesha Patel** (Optometrist)
Shri C. H. Nagri Municipal Eye Hospital, Ellisbridge, Ahmedabad – 380 006.
paruldanayak@yahoo.co.in

ABSTRACT

BACKGROUND :

This study aimed to understand the changes occurring in accommodation and vergence when a myopic patient changes from spectacles to contact lenses.

METHODS :

A prospective, non randomized study was carried out in a group of 25 subjects whose average age was of 23.16 ± 4.41 years. It included a group of habitual myopic contact lens wearers and some fresh wearers as well.

All the subjects underwent a thorough optometric examination. Subsequently a full binocular vision evaluation was performed with spectacles and contact lenses on the same day.

Several visual parameters that characterize the accommodative (accommodative amplitude, accommodative stimulus and accommodative facility) and binocular function (stereo acuity, cover test, horizontal dissociated phoria, vertical dissociated phoria, stimulus AC/A ratio, near point of convergence, negative relative accommodation, positive relative accommodation, positive fusional reserve, negative fusional reserve and vergence facility) were measured with myopic spectacles and contact lenses in these subjects.

RESULTS :

The following statistically significant differences were found with the use of spectacles and contact lenses in the accommodative and binocular function: increase in accommodative lag in both the eyes ($p < 0.005$), increase in accommodative facility ($p < 0.005$), objective near point of convergence advancing closer to the eye ($p < 0.005$), increase in negative relative accommodation ($p < 0.005$) and increase in vergence facility ($p < 0.005$) with contact lenses in comparison to the spectacles. No statistical differences were found in other accommodative and convergence parameters.

CONCLUSION :

From results obtained in this study, we can conclude that when one changes from spectacles to contact lenses, there is an increase in demand for accommodation and convergence which is in accordance with the theory that myopes who wear contact lenses accommodate more and converge more than spectacle wearers.

KEY WORDS : Myopia, Contact lenses, Spectacles, Accommodation, Convergence

INTRODUCTION

Theoretically, it has been considered from optical calculations, that myopes, who switch over from spectacles to contact lenses, will accommodate and converge more with the contact lenses as compared to the spectacle lenses. Hence the accommodative and convergence demands will also vary for each myopic subject with respect to the working distance.[1, 2, 3, 4]

In succession to accommodation, there occurs convergence and pupillary constriction of the eyes. A myope wearing contact lenses will converge more with contact lenses as compared to the spectacle lenses. The reason for this is that, when wearing spectacles, the spectacle lenses will behave as a base in relieving prismatic effect, therefore the eyes converge less than the viewing distance would suggest. With contact lenses, there remains a negligible amount of prismatic effect, thus the convergence demand when switching from spectacles to contact lenses may be clinically significant.[1] This is as presented in figure 1.

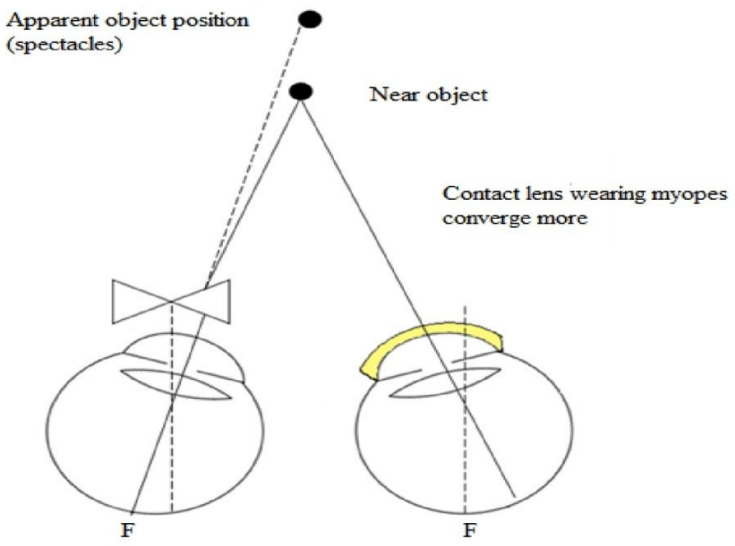


Fig 1 Convergence with spectacles and contact lenses in myopia

With the use of spectacles in myopia, it has been suggested that spectacle wearing myopes will have relatively lesser demands placed on their adduction reserves i.e. their positive fusional vergence demands will be less than the negative fusional vergence demands as compared to contact lenses. When contact lenses are placed on the myopic eye, the positive fusional vergence will increase and the negative vergence will decrease as compared to the spectacle lenses. [1]

AIMS AND OBJECTIVES

The aim of this study was to measure the differences in accommodative, convergence and binocular function in a group of habitual myopic spectacle and contact lens wearers.

This study was conducted to determine whether the measurement of these ocular parameters, would be different in the same subjects when wearing either soft contact lenses spectacle corrections, and to determine whether these values agree to those which would be predicted from optical calculations.

MATERIAL AND METHODS

A Prospective, Non- randomized study of 25 subjects was carried out at Shri C.H. Nagri Municipal Eye Hospital, Ahmedabad. The inclusion criteria were as follows:

Subjects aged between 15 – 35 years, at least - 0.50 Ds of myopia in both principal meridians of both the eyes, an astigmatic ametropia within ≤ 1.00 D, an anisometropia within ≤ 2.00 Ds of range, a stereo acuity of less than 60 seconds of an arch and a visual acuity of 6/9 – 6/6 for distance and a near vision of N6 at 40 cm in both the eyes.

Informed consent was obtained from all the subjects before enrollment. All the 25 subjects underwent a thorough ocular and optometric examination. The following chronologic order was maintained in all subjects. First all subjects underwent a thorough optometric examination and contact lens selection, thereafter an orthoptics and binocular evaluation was performed with spectacles and contact lenses.

The optometric workup included a proper history taking, sensory and motor evaluation of the eyes comprising of a stereo acuity test, Worth Four Dot Test, cover test for distance and near, visual acuity for distance and near with the Snellen's opto-types, a proper objective retinoscopy in both meridians of the eyes and a subjective refraction. Following this, binocular balancing with the help of the duo chrome test was done to equalize the visual acuity in the two eyes. Optometric examination was followed by a complete ocular examination which included a slit lamp examination, torchlight examination, pupillary evaluation, digital intraocular tension and an undilated direct ophthalmoscopy.

The orthoptics workup included stereo acuity measurements with the help of Random Dot Stereogram (RDS), horizontal and vertical dissociated phoria for distance and near with the help of cover test and Maddox Rod Test, inter pupillary distance and AC/A ratio calculation by the heterophoria method, near point of convergence, near point of accommodation, stimulus to accommodation i.e. MEM dynamic retinoscopy, negative and positive relative accommodation, positive fusional reserve and negative fusional reserve, accommodative and vergence facility.

These same test procedures were repeated with the contact lenses after an adaptation period of fifteen minutes. The soft contact lens fit was evaluated and then the binocular vision was evaluated with the soft contact lenses.

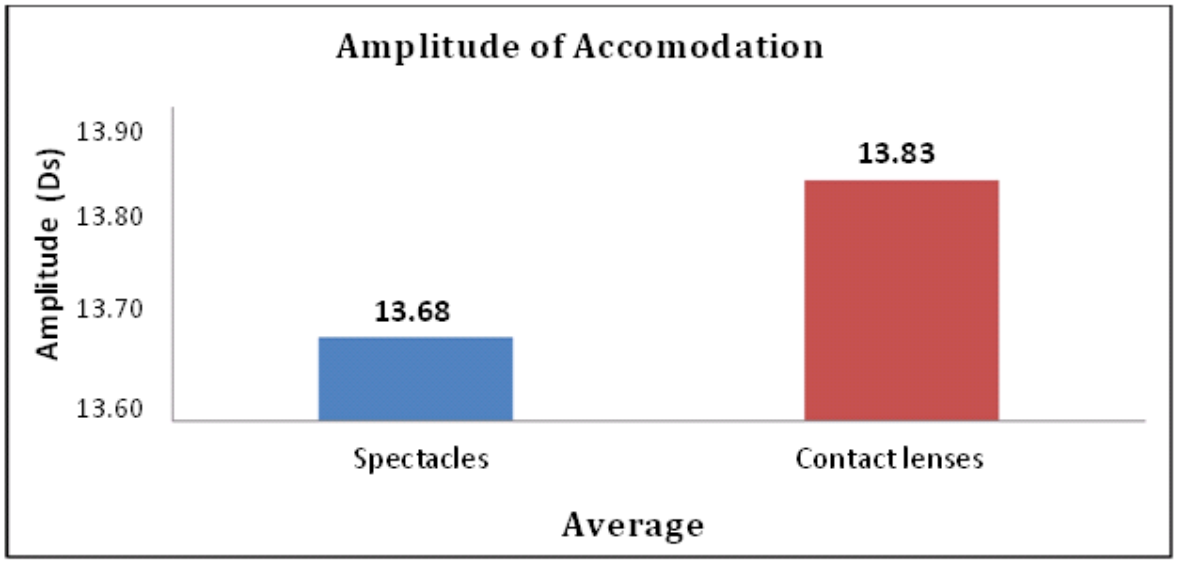
RESULTS :

All the subjects (n = 25) completed the study. The means (and standard deviations - SD) of all the measured parameters were calculated for each correction method, and are given in tables 1 and 2. The values for the parameters in the two groups were then compared using a two paired t-test. There was no statistically significant difference in accommodative amplitude noted. However, a significant difference was noted in the accommodative facility and the accommodative lag with the contact lenses as compared to spectacle lenses.

Parameter	Method		Mean ± SD	Mean ± SD	p value
		Eyes	Spectacles	Contact lenses	
Amplitude (Ds)	Push up technique	OD	13.45 ± 4.05	13.71 ± 4.58	0.57
		OS	14.29 ± 4.94	13.75 ± 5.06	0.26
		OU	13.30 ± 3.79	14.04 ± 5.13	0.20
Facility (cpm)	Flippers ± 2.00 Ds	OD	15.12 ± 5.56	17.22 ± 7.52	p < 0.005
		OS	15.82 ± 5.35	17.68 ± 6.19	0.02
		OU	13.91 ± 5.14	16.80 ± 6.24	p < 0.005
Accommodative Lag (Ds)	M.E.M.	OD	0.78 ± 0.30	1.06 ± 0.28	p < 0.005
		OS	0.89 ± 0.25	1.14 ± 0.27	p < 0.005

TABLE 1 – Accommodative system parameters with spectacles and contact lenses

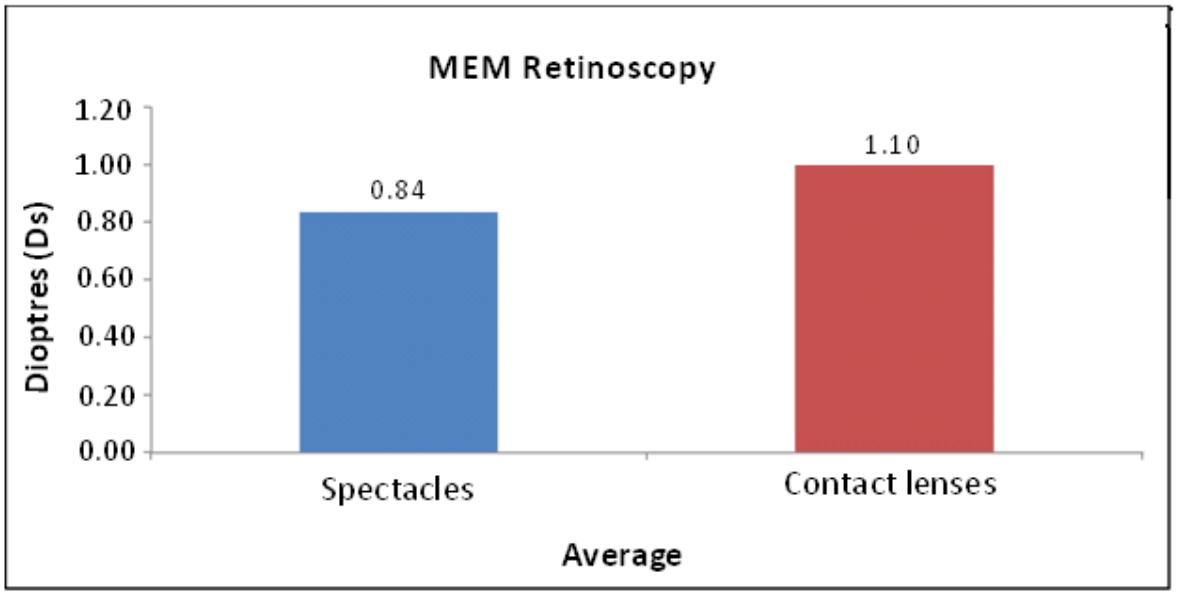
GRAPH 1:



As shown in Graph 1, it can be noted that the average accommodative amplitude increases with contact lenses (13.83 Ds ± 0.18 Ds) as compared to the spectacle lenses (13.68 Ds ± 0.53 Ds).

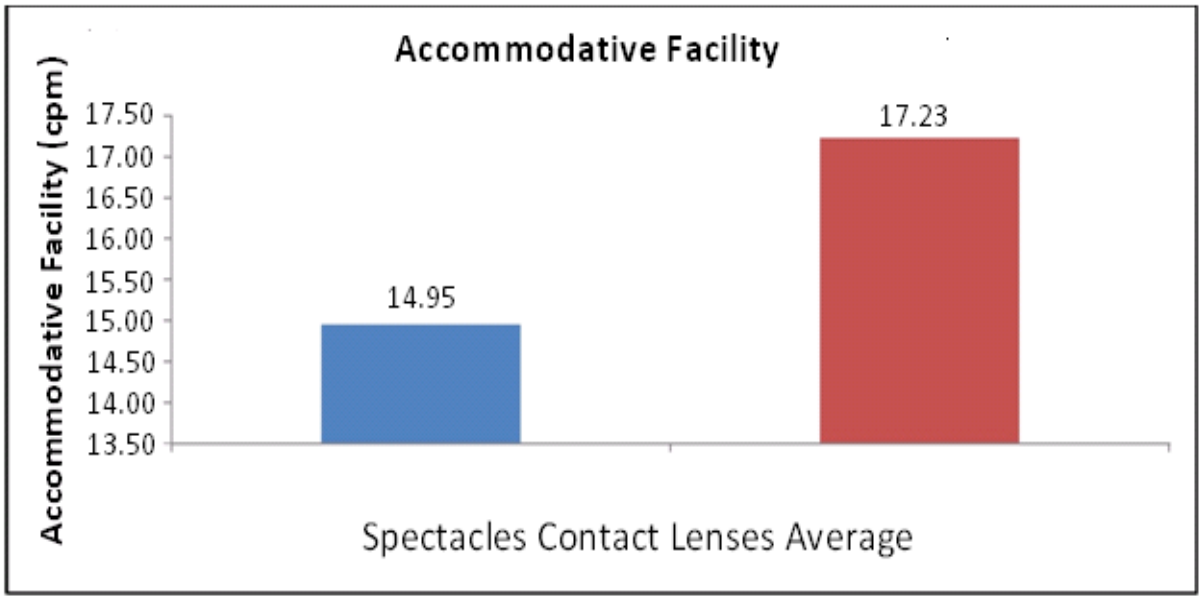
Therefore it can be seen that the average near point of accommodation advances closer to the eye with contact lenses (7.23 cm ± 0.09 cm) in comparison to spectacle lenses (7.32 cm ± 0.28 cm) with no statistical difference in either eye.

GRAPH 2:



The average accommodative response was noted to be higher with contact lenses (1.10 Ds ± 0.06 Ds) as compared to spectacles (0.84 Ds ± 0.08 Ds) from Graph 2. Hence, Graph 2 shows that with contact lenses, there is a lag of accommodation.

GRAPH 3:



In Graph 3, it can be seen that there is a statistical significant increase in the average accommodative facility when tested with contact lenses (17.23 cpm ± 0.44 cpm) in comparison to the spectacles (14.95 cpm ± 0.97 cpm).

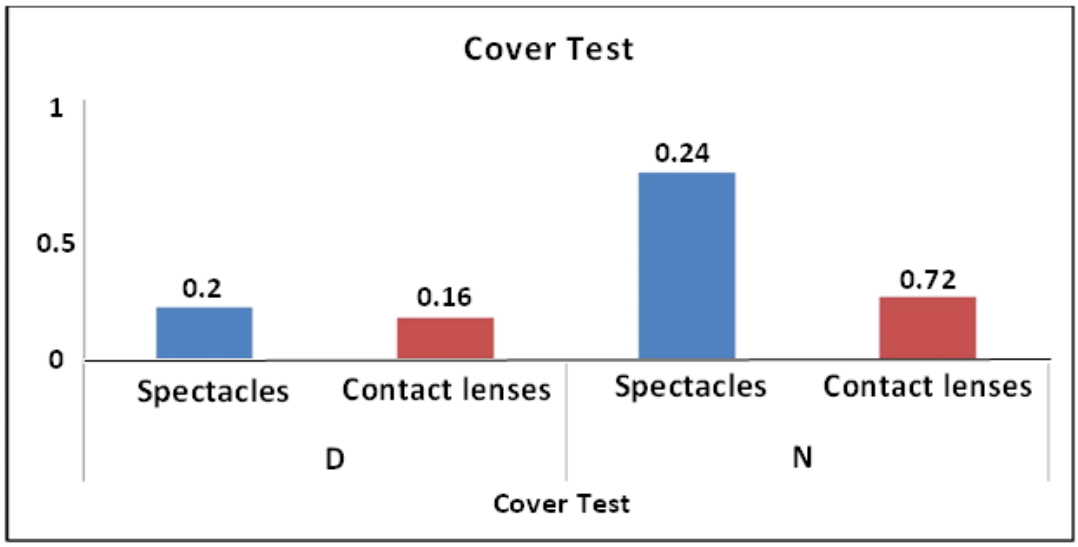
CONVERGENCE:

Parameter	Method	Mean ± SD Spectacles	Mean ± SD Contact lenses	p value
Stereo acuity (seconds of arch)	RDS	40.8 ± 2.77	40 ± 0.00	0.16
Near Point of Convergence (cm)	Objective break	5.92 ± 2.03	5.18 ± 1.66	0.02
	Subjective break	6.60 ± 2.41	6.35 ± 1.86	0.52
	Subjective recovery	8.26 ± 2.45	8.04 ± 2.48	0.62
Horizontal dissociated phoria ( )	Distance	- 0.52 ± 2.16	- 0.28 ± 2.31	0.27
	Near	- 1.58 ± 6.03	- 1.40 ± 6.03	0.34
Vertical dissociated phoria ( )	Distance	0.40 BU ± 0.74	0.36 BU ± 0.74	0.70
	Near	0.36 BU ± 0.80	0.30 BU ± 0.69	0.69
Negative Relative Accommodation (D)	Plus lenses	2.77 ± 0.28	2.92 ± 0.25	p < 0.005
Positive Relative Accommodation (D)	Minus lenses	- 3.14 ± 1.42	- 3.06 ± 1.24	0.57
AC/A Ratio (/ D)	Heterophoria method	5.76 ± 1.70	5.84 ± 1.63	0.44
Negative Fusional Vergence ( )	Blur	4.70 ± 2.79	4.59 ± 2.58	0.81
	Break	11.01 ± 3.17	10.79 ± 3.81	0.74
	Recovery	7.80 ± 5.14	6.82 ± 2.63	0.21
Positive Fusional Vergence ( )	Blur	20.78 ± 14.34	20.85 ± 12.99	0.98
	Break	37.38 ± 12.47	38.28 ± 13.08	0.60
	Recovery	25.40 ± 15.19	25.75 ± 13.60	0.83
Vergence Facility (cpm)	Flippers (12 BO/ 3 BI)	16.13 ± 4.71	18.55 ± 5.53	p < 0.005

TABLE 2 – Convergence system parameters with spectacles and contact lenses

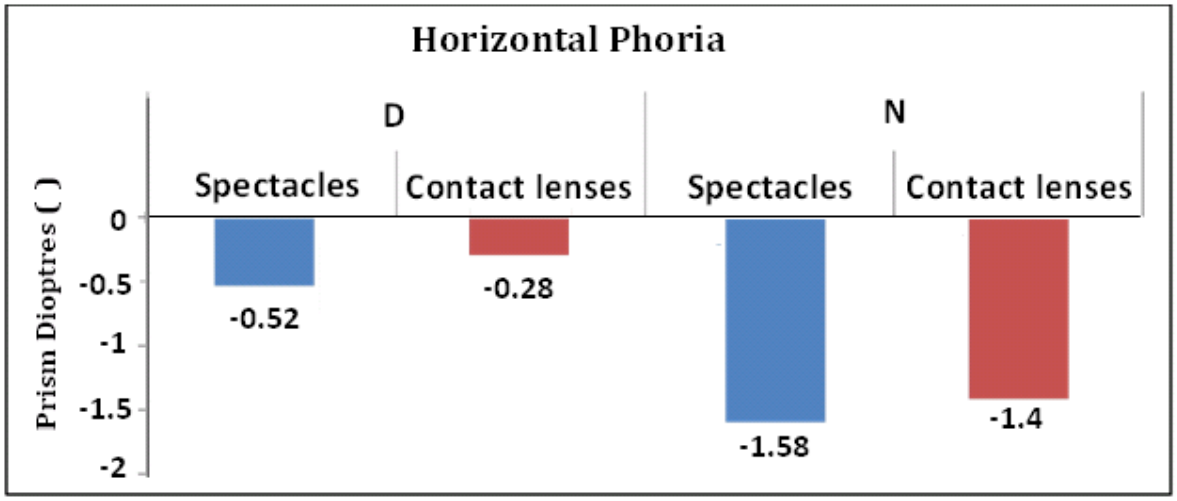
It can be seen from the above table that there is a statistically significant difference in the objective near point of convergence, the negative relative accommodation, and the vergence facility with contact lenses in comparison to the spectacles in the convergence parameters.

GRAPH 4:



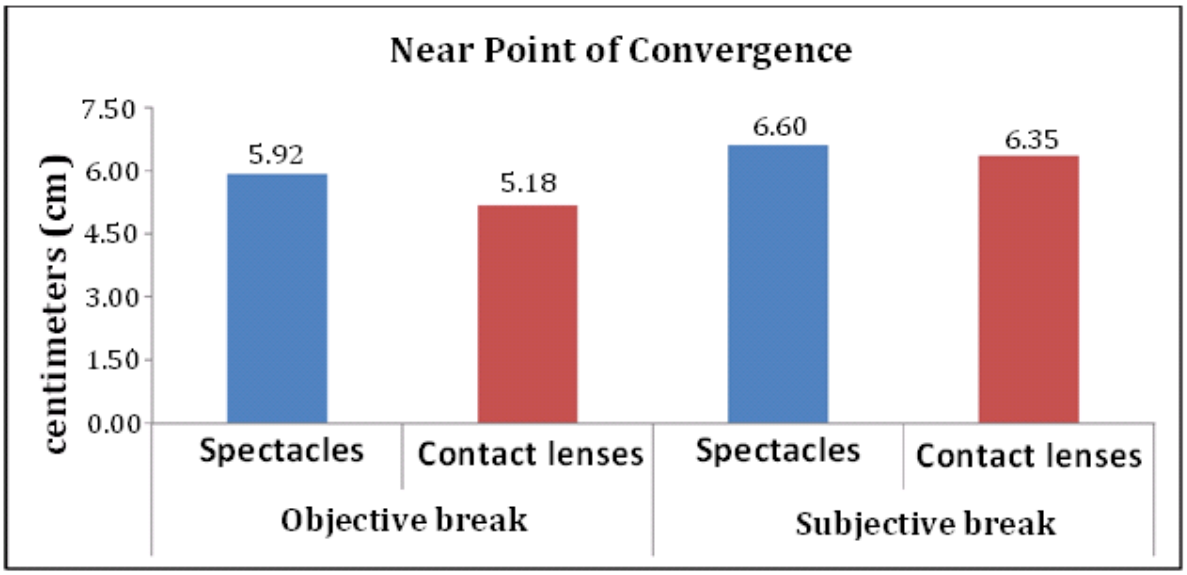
Graph 4 shows the correlationship of the cover test for distance and near. It can be seen that significant phoria which was present for distance has been reduced with the contact lenses. In these cases it was seen that the exophoria was getting reduced with the contact lenses as compared to the spectacles.

GRAPH 5:



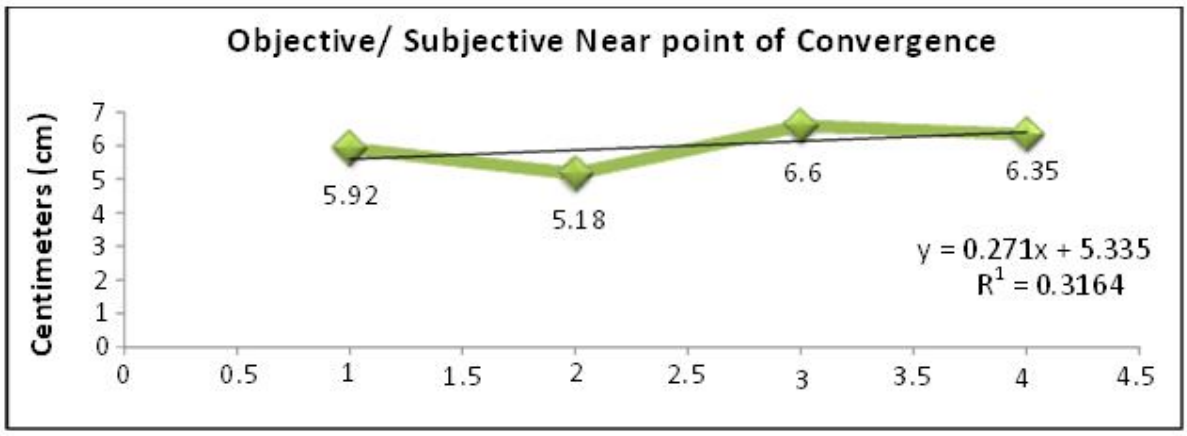
The above Graph 5 shows no significant difference in the phoria values. Horizontal dissociated phoria for distance and near showed less exophoric values with contact lenses (- 0.28 Δ ± 2.31 Δ, -1.40 Δ ± 6.03 Δ) as compared to spectacles (-0.52 Δ ± 2.16 Δ, -1.58 ± 6.03 Δ).

GRAPH 6:



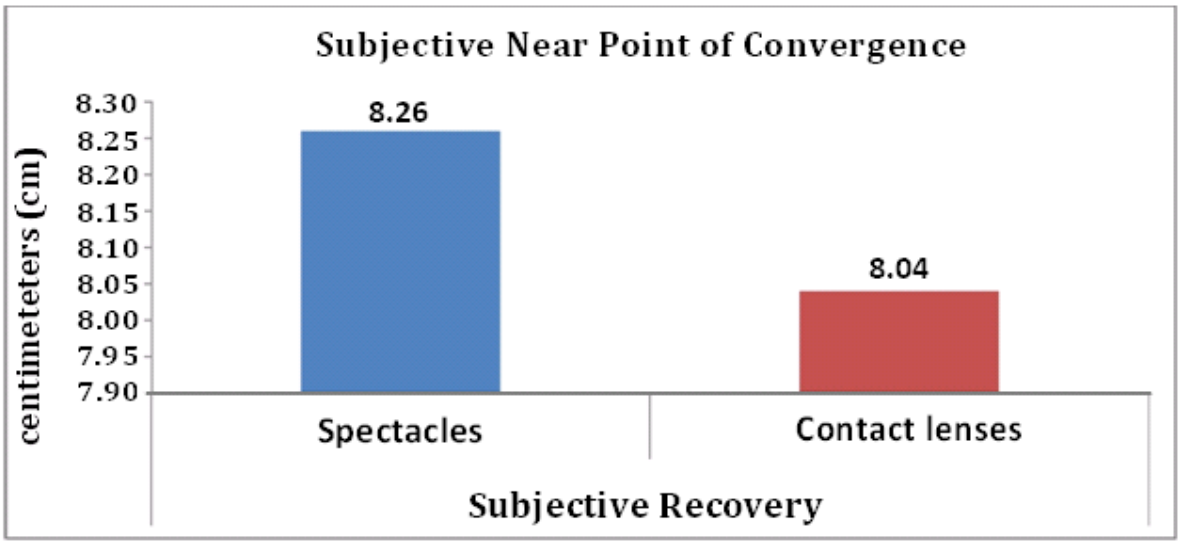
From Graph 6, it can be seen that there is a significant change in the near point of convergence when seen objectively with contact lenses (5.18 cm ± 1.66 cm) as compared to spectacle lenses (5.92 cm ± 2.03 cm).

GRAPH 7:



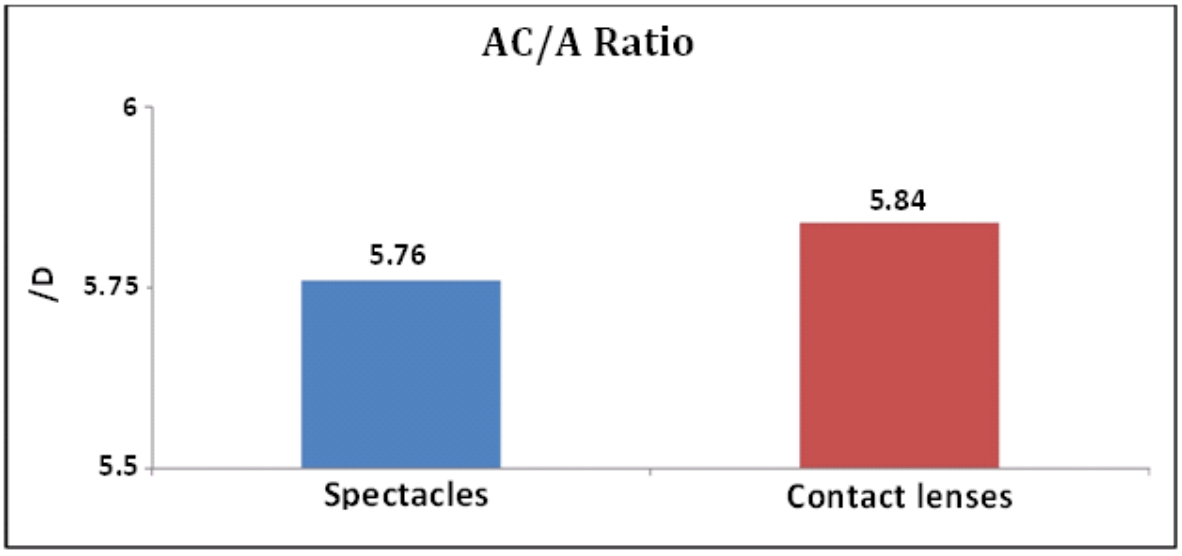
Graph 7 shows the correlation coefficient for the objective and subjective break for near point of convergence which was noted to be 0.32 approximately.

GRAPH 8:



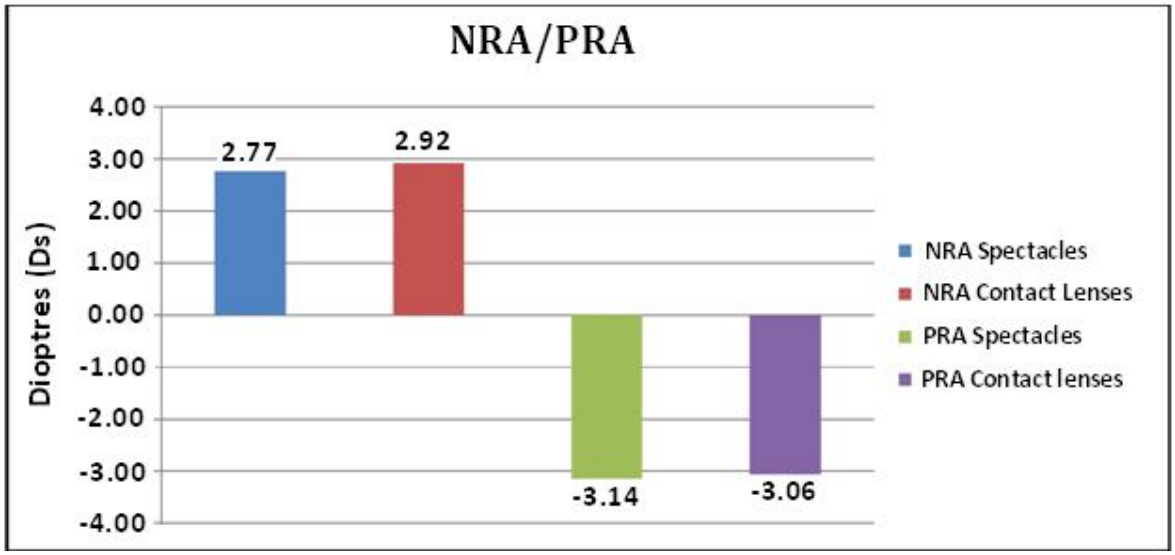
The recovery was noted to be on the lower side (8.04 cm ± 2.48 cm) with contact lenses indicating that the subjects were not able to diverge their eyes as compared to the spectacle lenses (8.26 cm ± 2.45 cm).

GRAPH 9:



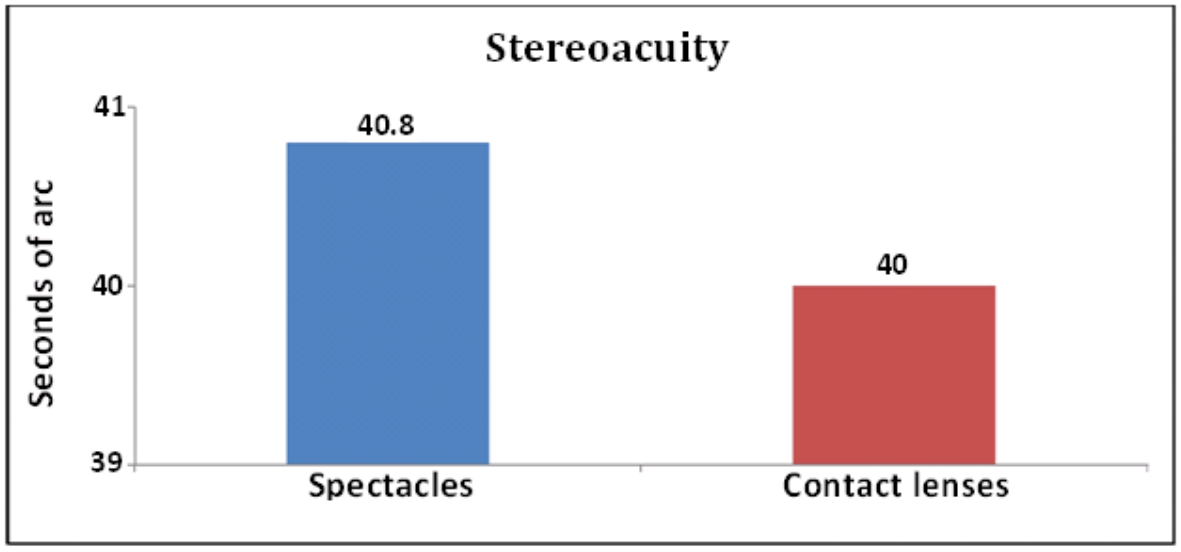
Graph 9 shows the AC/A ratio as calculated by the Heterophoria method, which increases with the contact lenses (5.84 Δ/D ± 1.63 Δ/D) as compared to the spectacles (5.76 Δ/D ± 1.70 Δ/D), but with no statistical difference.

GRAPH 10:



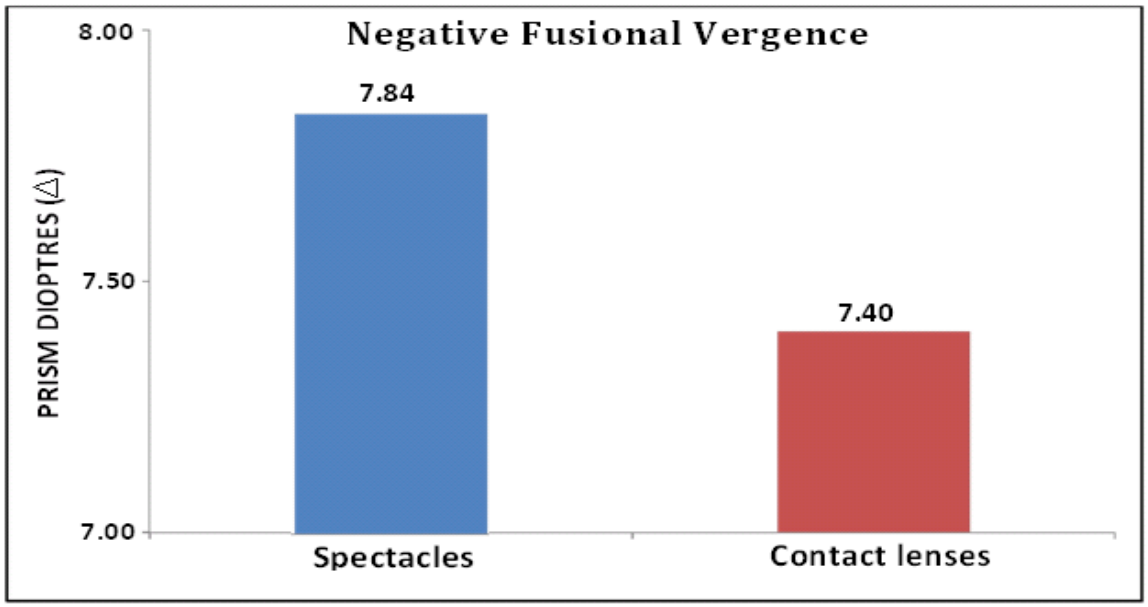
It can be seen from Graph 10 that there is a statistical significant increase in the negative relative accommodation with contact lenses (2.92 Ds ± 0.25 Ds), as compared to the spectacle lenses (2.77 Ds ± 0.28 Ds). The positive relative accommodation value shows a decrease with contact lenses (- 3.06 Ds ± 1.24 Ds) as compared to the spectacles (- 3.14 Ds ± 1.42 Ds) with no statistical difference in the positive relative accommodation value.

GRAPH 11:



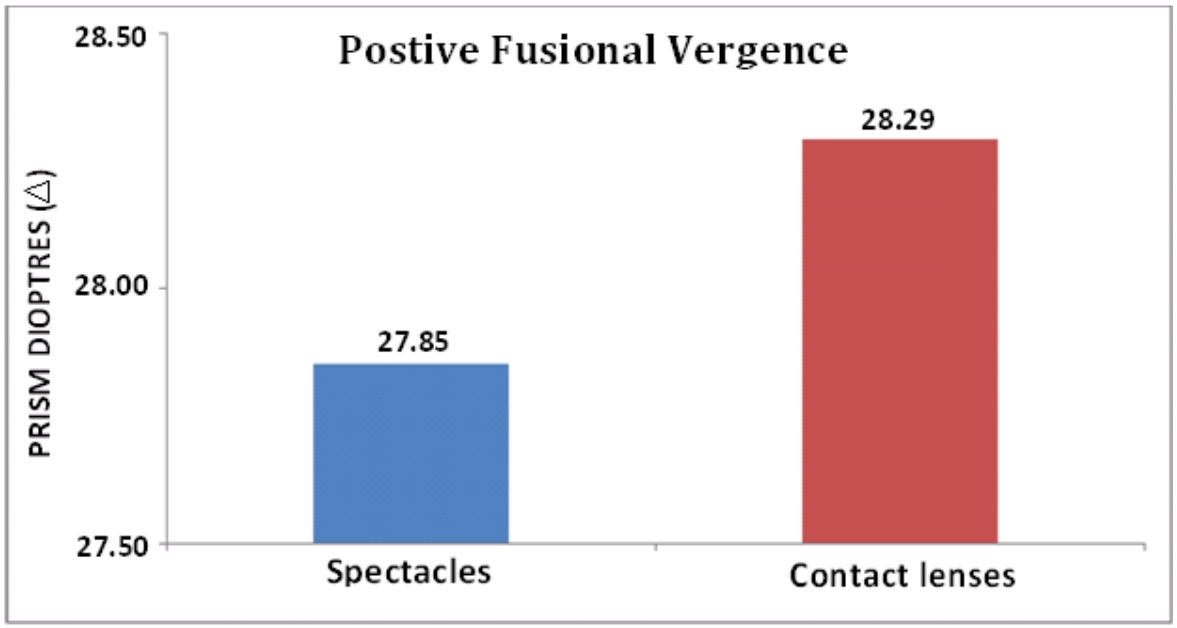
Graph 11 shows that there are no significant changes in the stereo acuity with contact lenses (40' ± 0.00') in comparison to the spectacles (40.80' ± 2.77').

GRAPH 12:



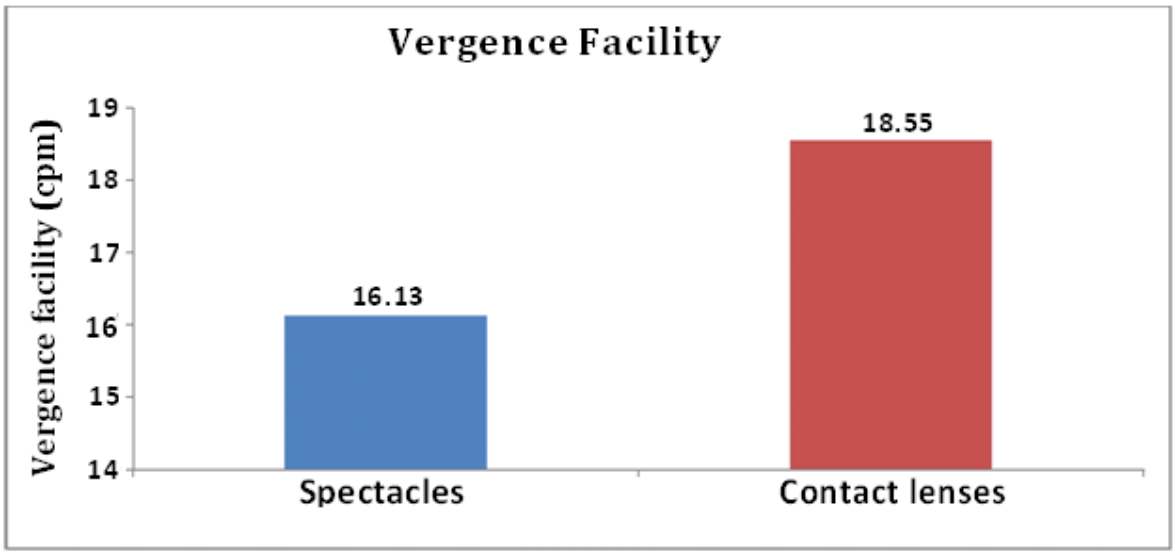
Graph 12 shows that the average negative fusional vergence decreases (7.40 Δ ± 3.14 Δ) with contact lenses as compared to the spectacles (7.84 Δ ± 3.16 Δ), with no statistical significance.

GRAPH 13:



The average positive fusional vergence increases for distance with the contact lenses (28.29 Δ ± 8.99 Δ) as compared to the spectacles (27.85 Δ ± 8.57Δ) with no statistical significance.

GRAPH 14 :



Graph 14 shows that the vergence facility increases with the contact lenses (18.55 cpm ± 5.53 cpm) as compared to the spectacle lenses (16.13 cpm ± 4.71 cpm) and this has a statistical significance also.

DISCUSSION :

As suggested by Fannin and Grosvenor, most contact lens wearers have the refractive errors ranging from ±1.00 D to ± 5.00 D (in our population- - 0.50 D to – 6.00 D), with the result that the change in accommodative convergence is not often a problem.[2,4] However the results found in our study were noted to be significantly different when comparing each of these variables found with contact lenses and spectacles.

Amplitude of Accommodation :

In our study, more accommodation was required by myopes when they changed from spectacles to contact lenses, this may suggest lower accommodative amplitudes with the spectacles. According to a study done by Carney (1977), to compare the accommodation with rigid and flexible contact lenses, both forms of contact lenses placed greater accommodative requirements on the myope than did the spectacle correction, but no significant difference was found between the two types of contact lenses in this respect.[8] In our study, the amplitude of accommodation was found to be increased with contact lenses although there was no statistical significance.

The short period of soft contact lens wearing in our study did not allow the adaptational changes in accommodative amplitude, therefore if contact lenses were used for several hours or days before taking the measurements, the results might be different as suggested by Raimundo et. al.[7]

Lag of Accommodation :

In our study the values for lag of accommodation were noted to be quite different. We saw that as the accommodative amplitude increases, there is an increase in the lag of accommodation. However as suggested by Schor et. al.[9], as the amplitude of accommodation

increases, the lag of accommodation may decrease due to the factor of tonic accommodation in darkness . These higher lag values could be an early sign of reduction in the amplitude of accommodation when soft contact lens are used for longer periods of time. As proposed by Goss and Zhai, an individual who does a great deal of near work, and whose accommodation lags more than normal, is prone to develop or to progress in myopia. [10]

Accommodative facility :

As suggested by Radha Krishnan, subjective and objective facility measurements showed a significantly lower facility rate in contact lens corrected myopes when compared with emmetropes at distance, but not at near. For near facility measurements, however, although velocity of relaxing accommodation was lower in myopes, velocity of accommodation was found to be similar in the two refractive groups.[11] This suggests that the facility rate will be equal with both contact lenses and spectacles. In the study by Raimundo et al, they found the values of accommodative facility were noted to be lower with contact lenses with no statistical significance.[7]

In our study, the accommodative facility showed a statistical significance. It increased with contact lenses, the possible reason for that may be the subjects were able to learn the test quickly and the test procedure was done on the same day.

Horizontal Phoria Status and AC/A Ratio :

In myopic subjects, because the optical stimulus for accommodation is greater with contact lenses, thus increasing the synkinetic function of accommodative convergence, one would expect that the near horizontal phoria would be more towards esophoria with contact lenses than with spectacles. If the wearer happens to be exophoric, the increase in the amount of accommodative convergence will result in a decreased exophoria and thus reduce the need for positive fusional vergence.[4, 12] Therefore the AC/A ratio also should increase.

As Westheimer and Stone suggested, the AC/A ratio also tended to remain the same with contact lenses and spectacles.[13, 14] In our study there was no relative difference in the AC/A ratio between the two correction methods although it was slightly on the higher side as suggested by Ogle.[12] The results in our study show that there is a reduction in the exophoria with near with contact lenses than spectacles which proves the same and a not very significant change in the AC/ A ratio.

Near Point of Convergence :

As stated by Raimundo et al, subjective break of near point of convergence and recovery did not vary significantly. [7] In our study we found though the subjective near point of convergence did not vary, the objective near point of convergence showed some variations. In all cases it was noted to be advancing towards the eyes with contact lenses than spectacles with a statistical significance.

Relative Accommodation and Fusional Vergences :

According to Raimundo, in his study, the NRA and PRA values were significantly different with contact lenses as compared to spectacles and this may be related more to the accommodative function than the binocular function.[7]

In our study the NRA was found to be lower with contact lenses. This would suggest that as the accommodative convergence decreases, there is divergence of the two eyes resulting in diplopia. To counteract this diplopia and to maintain binocular single vision at near, the subject must use the positive fusional reserve. With contact lenses, this prismatic effect is absent; therefore the NRA will be increased with contact lenses. Subsequently the PFV also should decrease and the NFV would increase to maintain the balance of the two eyes. [7] Even though, the values of NFV and PFV are not statistically significant, they may be significant from a clinical standpoint for this study. According to another study Gwaizda et. al and Goss et. al, the PRA was found to be noted lower in myopes who wore spectacles.[15, 16] In our study it was noted to be on the lower side than expected with contact lenses with no statistical significance.

Vergence Facility :

The vergence facility with contact lenses was noted to increase although there was no statistical significance as stated by Raimundo et. al.[7] In our study the vergence facility was noted to increase for the reason that patients were able to sustain the vergence dynamics and this may be due to learning of the test procedure itself.

Relation to Age and Presbyopia :

As the age increases, it can be assumed that a 4.00 Ds hyperopic presbyope who is wearing spectacles will require an add at an earlier age than a myope who wears spectacle lenses due to increase in the accommodative demand. If this same spectacle wearer shifts to contact lenses, the accommodative demand will decrease in cases of hyperopia and increase in cases of myopia. The newly presbyopic myope has to accommodate more with contact lenses as compared to the spectacles; hence it can hasten the progression of presbyopia. [2]

LIMITATIONS :

The limitations for this study are as follows: The test procedures were performed on the same day due to the lack of time provided by the subjects. No cycloplegic refraction was done although detailed care was being taken by performing fogging procedure. Hyperopes were not included for this study.

CONCLUSION :

From this study we can conclude, that there are some significant changes in the accommodative and vergence parameters when a myope who is wearing spectacles shifts to contact lenses. It can be concluded that myopes need to accommodate more and converge more with contact lenses as compared to spectacles and one factor is accommodative convergence which needs to be taken into due consideration while dispensing a contact lens to a myopic patient.

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