

Soft Contact Lens Effect on Intraocular Pressure Measurement

^{*1}Ayishetu Oshoke Shuaibu, ²Kingsley Nosayaba Bazuaye and ¹Beulah Motilayo George

¹Department of Ocular Health and Contact Lenses, Faculty of Optometry, University of Benin, Benin City, Edo State, Nigeria.

²Department of Low Vision and Vision Sciences, Faculty of Optometry, University of Benin, Benin City, Edo State, Nigeria.

*Corresponding authors' email: ayishetu.garuba@uniben.edu

ABSTRACT

Soft contact lenses (SCLs) are utilized for therapeutic purposes and correction of refractive errors. Where SCLs removal is not ideal and routine intraocular pressure (IOP) measurements are required, the need may arise for IOP measurements to be done with SCLs in situ. The aim of this study was to determine soft contact lenses effect on IOP measurement. 42 subjects with mean age of 22.56 ± 2.83 were included in the study. Baseline IOP was taken in right eye (OD), first with a Goldmann applanation tonometer (GAT) and then with the Keeler non-contact tonometer (NCT). The 42 subjects were then grouped into 7, each group comprised 6 subjects each group wore 0.00D, +3.00DS, +6.00DS, +9.00DS, -3.00DS, -6.00DS and -9.00DS Opticom SCLs on their OD. IOP was measured with NCT after 30 minutes of wearing these SCLs over the cornea of the OD. The IOP of the naked left eyes of the 42 subjects was also measured with NCT after 30 minutes. This served as an internal control. The data obtained were analysed. Results showed no statistical difference between the baseline mean values of IOP measured with NCT and GAT. The IOP values were significantly greater ($p = 0.007$; $p = 0.000$) for the groups with plus SCL powers of +6.00D and +9.00D respectively and significantly reduced ($p = 0.019$; $p = 0.005$) for the groups with minus SCL powers of -6.00D and -9.00D of Opticom SCLs respectively.

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INTRODUCTION

The importance of screening the intraocular pressure of patients cannot be overemphasized given that only about half of the estimated 70 million people worldwide with glaucoma know that they have the condition and the fact that IOP is not only the most significant risk factor for the development of glaucoma, but also the a vital parameter for which its management reduces both the incidence and the prevalence of the disease (Cordeiro et al, 2026). Therefore, intraocular pressure is an essential ocular parameter often measured in eye care facilities.

Soft contact lenses (SCLs) are made from biomaterials which are compactable with body tissues and fluids (Onigbara *et al.*, 2026). They are often used in the correction of refractive errors and therapeutically for ocular conditions like epithelial defects, filamentous keratitis, bullous keratopathy and in corneal post-refractive surgery by Ophthalmologists (Lim&lim, 2020; Wang & Jacobs, 2022). During review appointments, due to the presence of ocular conditions, it is most times not feasible to take off the soft contact lenses for intraocular pressure measurement. This is because the frequent removal of the soft contact lenses used for therapeutic purposes in these corneal diseases affects the corneal healing negatively (Lim&Lim, 2020; Wang & Jacobs,2022). In these patients, obtaining accurate intraocular pressure (IOP) value is vital for follow-up and treatment plan for the patient.

Intraocular pressure is measured in clinical settings by means of either contact or non-contact tonometry. Non-contact tonometry (NCT) has become widely available for measuring IOP because it is convenient, non-invasive and carries less risk of spreading infection than is the case with Goldmann

applanation tonometry (Erdogan *et al.*, 2018). GAT has a few more demerits like the use of topical anaesthesia to reduce patient's uneasiness, staining with fluorescein and the increased risk of corneal injury while measuring IOP. Also, measuring IOP with GAT (the gold standard for comparison of other tonometry methods) may not be usable if the corneal integrity is compromised such as in epithelial erosion, or in corneal pathology or when corneal surface is irregular (Seol et al, 2019).

Despite the increasing use of soft contact lenses, studies have reported different findings regarding the measurement of IOP with contact lens in place over the cornea. Some studies have shown that SCLs have an effect on IOP measurement while some others have shown otherwise; some studies have also attributed the effect to the contact lens thickness, the lens material or the type of instrument used (Patel and Illahi, 2004; Ogbuehi, 2012; Zeri *et al.*, 2016). Therefore, this study seeks to determine soft contact lenses effect on intraocular pressure measurements and investigate whether any observed changes can be attributed to the lens power.

MATERIALS AND METHODS

This prospective experimental study was conducted in the Optometry clinic of University of Benin, Benin City. Sample selection was based on subjects who met the inclusion criteria and agreed to participate in the study. Subjects between ages of 18 – 35 years that complied with the lens wearing procedures, no ocular diseases and with astigmatism of less than 2 diopter were included for the study. Those who had history of soft contact lens intolerance were screened out from the study.

Participants were subjected to a comprehensive ocular examination including visual acuity, external and internal examination and autorefractor measurement to select subjects having refractive errors with corneal astigmatism less than 2.00D and subjects without ocular pathology. Schirmer test and Tear Break-up time test were carried out on all subjects to exclude those with dry eyes tendencies. The central corneal thickness (CCT) of each subject was evaluated with a Pachpen handheld pachymeter and subjects with CCT within the normal range of 540-550 μ m (Mean CCT 547 $\pm$ 29.5 μ m) were used to avoid the effect of CCT on IOP measurements. A total of forty-two (42) subjects, aged 18-35 (mean age 22.56 $\pm$ 2.83) years, were enrolled for this study. They were instructed to wear light clothes without tight collar when coming to the clinic for the experiment. In the clinic, the subjects were instructed to sit down comfortably and rest while IOP was being measured. All IOP were measured within the hours of 9am-12noon to avoid diurnal variation effect on IOP.

All forty-two (42) subjects had their baseline IOP measured in the experimental eye (right eye) first with a Goldmann applanation tonometer (GAT) after it has been anaesthetised with a drop of tetracaine 0.5% and stained with sterile fluorescein sodium strip. The GAT values measured for all the subjects were recorded as standard IOP measurements, taking the GAT as the Gold Standard for IOP measurement. Thereafter, the baseline IOP was measured again in the both eyes of all 42 subjects using the Keeler Pulsair IntelliPuff non-contact tonometer. The forty-two (42) subjects were then divided into seven (07) groups, each group comprised six (06) subjects and they wore the following powers of contact lenses on their right eye. Group 1 subjects wore 0.00D SCLs, group 2 subjects wore +3.00DS SCLs, group 3 subjects wore +6.00DS SCLs, group 4 subjects wore +9.00DS SCLs, group 5 subjects wore -3.00DS SCLs, group 6 subjects wore -6.00DS SCLs and group 7 subjects wore -9.00DS SCLs. IOP was then measured after 30 minutes of wearing the respective

Opticom soft contact lenses of the different powers of 0.00D, +3.00D, +6.00D, +9.00D, -3.00D, -6.00D and -9.00D in situ over the cornea of the right eye. The IOP of the left eye of the forty-two subjects was also measured after 30 minutes. The left eye was used as an internal control while the right eye served as the experimental eye. IOP was assessed three times at two minutes interval and the average value recorded for each subject.

The data obtained from this study was presented in tables and statistical data analysed using Independent Sample T-Test at 0.05 level of significance. Ethical approval was collected from the Departmental Research and Ethics Committee of the Optometry Faculty, University of Benin, Benin City in accordance with the tenets of the declaration of Helsinki. After the purpose of the research study was explicitly explained to all the subjects to ensure full understanding and cooperation during the research study. Informed consent was obtained from all subjects before data collection.

RESULTS AND DISCUSSION

The study population consisted of forty-two subjects (n = 42); 20 males and 22 females, who were with mean age of 22.56 $\pm$ 2.83. Table 1 shows the results of the difference between the mean baseline IOP values measured with NCT on naked cornea and mean baseline IOP values measured with GAT on naked cornea for groups 1, 2, 3, 4, 5, 6 and 7 subjects. No statistically significant difference was found between the mean baseline IOP values measured with non-contact tonometer (NCT) and baseline IOP measured with Goldmann applanation tonometry (GAT) for all the subjects in the seven groups. The results of this study are in agreement with the study of Lin *et al.*, (2023) where they reported that no differences in readings of IOP taken by NCT and GAT. Therefore, this implies that NCT may be a relative alternative in the measurement of IOP to GAT, which is considered the gold standard.

Table 1: Showing the Mean Baseline IOP Values (Right Eye) of GAT and NCT for Groups 1-7 Subjects

Groups of subjects	Mean IOP $\pm$ SD values (mmHg) using GAT without SCLs	Mean IOP $\pm$ SD values (mmHg) using NCT without SCLs	Mean Δ IOP	p-value
Group 1	11.95 $\pm$ 1.34	13.20 $\pm$ 1.32	1.25 $\pm$ 0.02	p = 0.134
Group 2	11.33 $\pm$ 2.72	12.25 $\pm$ 2.88	0.92 $\pm$ 0.16	p = 0.583
Group 3	13.38 $\pm$ 2.88	14.13 $\pm$ 2.81	0.75 $\pm$ 0.07	p = 0.658
Group 4	13.32 $\pm$ 1.66	13.90 $\pm$ 1.46	0.59 $\pm$ 0.20	p = 0.533
Group 5	11.37 $\pm$ 1.40	12.53 $\pm$ 1.22	1.16 $\pm$ 0.08	p = 0.173
Group 6	11.33 $\pm$ 2.08	12.60 $\pm$ 1.83	1.27 $\pm$ 0.25	p = 0.289
Group 7	13.33 $\pm$ 1.59	14.60 $\pm$ 1.55	1.26 $\pm$ 0.04	p = 0.193

Table 2 shows the mean IOP value (13.20 $\pm$ 1.32 mmHg) gotten without SCLs on and the mean IOP value (14.67 $\pm$ 1.49 mmHg) gotten with 0.00D lenses in situ over the cornea as measured with the NCT in the right eyes of group 1 subjects. There was an increase in IOP value with the 0.00D lenses (Plano lenses) when repeated measurement was taken over the lens after 30 minutes of insertion. Although, the mean difference in intraocular pressure readings was not statistically significant (p=0.150). The result of this study

aligns with the study of Anton *et al.*, (2013). Their results showed no statistically significant difference between IOP measurements made over therapeutic 0.00D soft contact lens and the baseline IOP measurements using the Air-puff NCT. Likewise, the result of this study is in agreement with the study of Bozgul *et al.*, (2012). They concluded that IOP measurements made with NCT over silicone hydrogel soft contact lens of 0.00 D power does not significantly affect IOP values.

Table 2: Showing Mean IOP Values (Right Eye) with and without 0.00D Lens using NCT for Group 1 Subjects

Mean IOP $\pm$ SD values (mmHg) using NCT without SCL	Mean IOP $\pm$ SD values (mmHg) with 0.00D SCL	Mean Δ IOP values	p-value
13.20 $\pm$ 1.32	14.67 $\pm$ 1.49	1.47 $\pm$ 0.17	p = 0.150

Table 3 shows the mean IOP values gotten without SCLs on and the mean IOP values gotten with +3.00D, +6.00D and

+9.00D lens powers in situ in the right eyes of groups 2, 3 and 4 subjects respectively as measured with the NCT. There was

an increase in IOP values with the hyperopic lenses (plus lenses) when repeated measurements were taken over the lenses after 30 minutes of insertion. The mean difference in intraocular pressure readings was not statistically significant ($p=0.085$) with plus lens power of +3.00D. However, it was found that the mean difference in intraocular pressure values was significantly greater ($p=0.007$; $p=0.000$) with +6.00DS and +9.00DS respectively. This result is in agreement with the study of Takenaka *et al.*, (2015). Their results showed that the IOP measurements obtained with the NCT while subjects wore +5.00 D lenses were significantly higher than those taken without contact lens on. The result is also in agreement with the study of Ogbuehi (2012). Results from his work showed that IOP significantly increased when measurements were taken with the NCT over +6D lenses. The study also mirrors the study of Patel and Illahi (2004) were their results showed that mean IOP values significantly changed for lens powers of +6.00 D and above ($p<0.01$). They concluded that

non-contact tonometry can be done with sufficient accuracy over a soft lens if the power is not greater than +3D.

However, it was observed that the result of this study is at variance with the study of Zeri *et al.*, (2016) were they investigated the accuracy of intraocular pressure (IOP) measurements using rebound tonometry over disposable hydrogel (etafilcon A) contact lenses of positive powers. The CLs had powers of +2.00 D and +6.00 D. Results showed that the IOP measurement obtained with +2.00 D and +6.00 D CLs was significantly reduced compared to measurements without CLs (t test; $p < 0.001$) but the two powers of CLs showed no notable difference. There are two possible reasons why their findings were at variance with this study. First, is the type of tonometer used. Rebound Tonometer (ICare) was used in their study while Keeler Pulsair IntelliPuff non-contact tonometer was used in our own study. Secondly, the type of contact lens used in their study was different from the type used in our study.

Table 3: Showing Mean IOP Values (Right Eye) with and without SCL Powers of +3.00D, +6.00D and +9.00D Measured with NCT for Groups 2, 3 and 4 Subjects

SCL powers	Mean IOP $\pm$ SD values (mmHg) using NCT without SCLs	Mean IOP $\pm$ SD values (mmHg) using NCT with SCL	Mean Δ IOP values	<i>p</i> -value
+3.00D	12.25 $\pm$ 2.88	15.98 $\pm$ 3.82	3.73 $\pm$ 0.94	$p = 0.085$
+6.00D	14.13 $\pm$ 2.81	19.75 $\pm$ 3.01	5.62 $\pm$ 0.20	$p = 0.007$
+9.00D	13.90 $\pm$ 1.46	20.35 $\pm$ 1.92	6.45 $\pm$ 0.46	$p = 0.000$

Table 4 shows the mean IOP values gotten without SCLs on and the mean IOP values gotten with -3.00D, -6.00D and -9.00D lens powers in situ in the right eyes of groups 5, 6 and 7 subjects respectively as measured with NCT. There was a decrease in IOP values with myopic lenses (minus lenses) when repeated measurement was taken over the lenses after 30 minutes of insertion. The mean difference in intraocular pressure readings was not statistically significant ($p=0.432$) with minus lens power of -3.00D. This result is in agreement with the study of Allen *et al.*, (2007). They concluded that precise IOP assessment can be obtained through a silicone hydrogel therapeutic contact lens of lower powers without the need to remove the contact lens. This will be valuable to patients who require IOP measurement while wearing contact lenses for therapeutic use.

Conversely, the consequence of taking IOP over minus lenses greater than -3.00DS is an underestimation of IOP values and it was found that the mean difference in intraocular pressure values was statistically significant ($p=0.019$; $p=0.005$) for minus lenses of -6.00DS and -9.00DS respectively. This result is also aligns with Ogbuehi (2012). Results from his experiment showed that IOP significantly decreased ($P < 0.05$) when measurements were taken with the NCT over -6D lenses. Also, our result is in agreement with that of Liu *et al.*, (2011). Their result showed a statistically significant difference in mean IOP values between eyes without lenses and those with CL powers of -6.0 D and above. They concluded that IOP measurement through myopic SCLs by NCT may be inaccurate most especially in high myopic lenses.

Table 4: Showing Mean IOP Values (Right Eye) with and without -3.00D, -6.00D and -9.00D Soft Contact Lenses Measured with NCT for Groups 5, 6 and 7 Subjects

SCL powers	Mean IOP $\pm$ SD values (mmHg) using NCT without SCLs	Mean IOP $\pm$ SD values (mmHg) using NCT with SCL	Mean Δ IOP values	<i>p</i> -value
-3.00D	12.53 $\pm$ 1.22	11.93 $\pm$ 1.32	-0.60 $\pm$ 0.10	$p = 0.432$
-6.00D	12.60 $\pm$ 1.83	9.77 $\pm$ 1.69	-2.83 $\pm$ 0.14	$p = 0.019$
-9.00D	14.60 $\pm$ 1.55	11.57 $\pm$ 1.33	-3.03 $\pm$ 0.22	$p = 0.005$

Conclusion

The effect of hyperopic (plus) lenses on IOP readings when measured with NCT is that it overestimates the IOP readings when the lens power is greater than +3.00D. On the contrary, the measurements obtained while wearing -6.00D and -9.00D SCLs over the cornea were significantly lower than those of the naked eyes measured with NCT. Therefore, the effect of myopic (minus) lenses on IOP readings when measured with NCT is that it underestimates the IOP readings when the lens power is greater than -3.00D.

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