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Intraocular Pressure by Noncontact Tonometry With and Without Soft Contact Lenses.

Abstract:

In some instances it is advantageous, both to the patient and doctor, to measure intraocular pressure (IOP) without removing soft contact lenses. This study examines the accuracy of IOP measurements taken by a Reichert AT550 non-contact tonometer on eyes wearing soft contact lenses. Lenses of various powers were included in the study to determine if differences in lens thickness resulted in a variation of IOP measurement. It was shown that reliable IOP readings can be obtained through soft contact lenses regardless of the lens power.

Introduction:

This study examines the accuracy of IOP (intraocular pressure) measurements taken by a non-contact tonometer on eyes wearing soft contact lenses. The non-contact tonometer has been reported to provide reliable intraocular pressure measurements on healthy corneas when compared with measurements made by Goldmann applanation tonometry (7). Since the non-contact tonometer is best suited to measure IOP without the need for corneal contact or anesthesia and because it is ideal as a mass screening device, its reliability in patients wearing soft contact lenses is important.

In many instances it may be preferable to measure IOP with soft contact lenses on the eye. Diseased corneas are often fit with therapeutic contact lenses to relieve pain, protect the eye and improve visual acuity (8). Eyes fit with these lenses frequently need IOP measurements and the added irritation of removing and reapplying the bandage lens may delay epithelial healing (8). In addition, many patients are apprehensive concerning the measurement procedure which may lead to invalid readings associated with an increased heart rate, blood pressure and lid tone. These patients are often able to relax and accept the procedure when a soft contact lens is left in place to serve as a 'barrier' (6). For these reasons, it has become common place to take IOP measurements through a contact lens (8). However this raises the question of the accuracy of such measurements.

This study holds importance for all eye care providers. It is commonly understood that alterations of corneal thickness impact IOP measurements (2). This study will examine the effects on IOP when the corneal thickness is

artificially increased by soft contact lens wear. The results will be examined for both myopic and hyperopic prescriptions and evaluated for significance. Anyone who fits soft contact lenses may benefit from reading this study because the possibility of taking IOP measurements over soft contact lenses could introduce a more comfortable, less invasive procedure for many of their patients. The need to use topical anesthetic or fluoroscein stain for IOP measurement may be significantly reduced.

Materials and Methods:

This study measured the IOP of 30 patients. The measurements were taken both with and without soft contact lenses on the eye. The patient base was comprised of patients from an educational optometry clinic. They were recruited on a volunteer basis from the students, faculty and patients. Only patients with healthy, normal corneas were included. Any subject with -1.50D or greater of cylinder was excluded.

Prior to participation, each subject was advised of the risks and benefits of the procedure. Use of NCT poses no risk to the subject. The device never contacts the eye and therefore no anesthetic is required. Each subject was also advised that if an abnormally high IOP was detected it would be recommended that they have a full eye exam with a glaucoma evaluation from an optometrist or ophthalmologist. Each subject then signed an informed consent form. To protect their privacy they were also assigned a number. From this point on they are identified by this number and not by name. Once the consent forms had been signed, the thirty subjects were randomly assigned to two groups, group A and group B. Group A subjects were seated in front of the NCT. The contact lens power was recorded. Three IOP readings were taken on each eye and then averaged. The lenses were then removed from the subject and NCT was once again performed on each eye. All results were recorded and the subjects dismissed. Group B subjects were first asked to remove their lenses. The contact lens power was recorded. They were then seated in front of the NCT and three IOP readings were obtained on each eye. The lenses were then placed back on the eye and NCT was once again performed. The results were recorded and the subjects dismissed.

The second part of the study involved using our data to perform statistical analysis. We began by comparing group A and group B to see if the actual act of applying and removing the contacts would make a difference. The mean, deviations from the mean, sum of squares and variance was found for group A. Using these values a t-test was performed with a 95% confidence interval and N=30. The same calculations were then performed using the data from Group B. With these calculations complete we then looked at the contact lens power to see if it would have an effect on the accuracy of the IOP measurement. We divided the data into two groups based on lens power. Group 1, -0.25D to -4.00D and Group 2, -4.25 to -10.00D. Once again the mean, it's deviations and variance were calculated. A t-test was performed using p=.05 (95% confidence).

Results:

Table 1:
Group A; Average IOP measurements taken first with the contacts in place and then without them. OD measurements listed first.

	Rx	IOP with CL's	IOP Without CL's
1	-2.25	11	11
	-3.25	10	11
2	-2.75 -0.50x160	13	13
	-2.75 -0.50x160	13	13
3	-2.25 -0.75x140	13	12
	-2.25 -1.00x030	12	12
4	-5.75	12.5	12.5
	-4.50	13.7	12.5
5	+0.75	11	11
	-1.25	10.5	11
6	-3.25	11.5	12
	-2.75	11.5	13
7	-3.75 -0.75x180	15.7	12.7
	-4.00 -0.75x170	12.3	11.5
8	-4.00	15	14
	-4.00	15	15.5
9	-7.00	12	14.3
	-7.00	13.7	14.3
10	-6.50	11.5	11.5
	-7.00	12.5	12
11	-9.25	11	11.5
	-10.00	11	11
12	-4.50	16.5	16
	-4.50	15	16
13	-5.25	13.5	12.5
	-5.25	12.5	13
14	-5.00	11	11.5
	-5.50	12	11
15	-6.00	11.5	11
	-6.25	10	11.5
x		12.48	12.49
SS		82.148	65.019

calculation results:
$t = -0.0243145$
$t_{0.05(2),v} = 2.002$
Ho: $u_1 = u_2$

If $|t| \geq t_{0.05(2),v}$ then reject Ho
Therefore, do not reject Ho (9).
Table 2:
Group B; Average IOP measurements take without the contacts in place and then with them. Once again OD measurements are listed first.

	Rx	IOP with CL's	IOP Without CL's
1	-4.25	12	11.3
	-4.00	11.7	11
2	-3.50	11.7	11
	-4.00	10.3	11.3
3	-2.50	13	15.3
	-2.25	14	13.3
4	-3.50	11	13
	-3.50	11.3	12.7
5	-5.00	13.3	16.3
	-5.00	12	12.7
6	-5.00	13	14.7
	-5.00	12	11.3
7	-7.00	19	20.7
	-7.50	18	18.7
8	-7.00	10.5	11.5
	-6.50	12	11.5
9	-3.75	10	11
	-3.75	10	10
10	-2.00 -1.25x180	12.5	15
	-1.75 -1.25x170	15	17
11	-2.00	14	11.5
	-1.00	13.5	12.5
12	-1.50	13	14
	-1.75	13	12.5
13	-0.75	18	17.5
	-0.75	17	15.5
14	-3.75	18.5	16
	-3.00	20	18
15	-7.00	13.5	14
	-7.00	15.5	14
x		13.61	13.83
SS		228.987	211.039

$t = -0.309345$
$t_{0.05(2),v} = 2.002$
Therefore, do not reject Ho (9).

Table 3: Average IOPs with and without contacts arranged by Rx

-0.25D to -4.00D with CL's	-4.25D to -10.00D with CL's	-0.25D to -4.00D without CL's	-4.25D to -10.00 D without CL's
10	13.5	11	14
10	15.5	10	14
12.5	12	15	11.3
15	13.3	17	16.3
14	12	11.5	12.7
13.5	13	12.5	14.7
13	12	14	11.3
13	19	12.5	20.7
18	18	17.5	18.7
17	10.5	15.5	11.5
18.5	12	16	11.5
20	12.5	18	12.5
11.7	13.7	11	12.5
11.7	15	11	14
10.3	15	11.3	15.5
13	12	15.3	14.3
14	13.7	13.3	14.3
11	11.5	13	11.5
11.3	12.5	12.7	12
11	11	11	11.5
10	11	11	11
13	16.5	13	16
13	15	12	16
12	13.5	12	12.5
10.5	12.5	11	13
11.5	11	12	11.5
11.5	12	13	11
15.7	11.5	12.7	11
12.3	10	11.5	11.5

x:	13.03	13.13	13.01	13.39
SS	194.81	131.1	130.95	164.91

$t_1 = 0.0381$
$t_2 = -0.43405$
$t_{0.05(2),v} = 2.048$
Ho: $u_1 = u_2$
Therefore, do not reject Ho (9).

Discussion:

The first two tables give the average IOP both with and without the soft contact lenses on the eye. Table 1 lists the results for Group A and table 2 lists the results for Group B. Table 3 incorporates Groups A and B and examines the effect of contact lens power. Values from tables 1 and 2 were placed under the appropriate column of table 3 based on contact lens power.

In addition to determining the effect of having a soft contact lens on the eye while measuring the IOP with a non-contact tonometer, we were also interested in whether the physical act of removing or applying a contact lens would alter the IOP. Could the manipulation of the globe during insertion and removal of a soft contact lens cause a massage effect and thus alter the IOP? Comparing Group A to Group B showed no significant difference in IOP. Therefore, lens manipulation does not seem to alter IOP measurement. Combining Groups A and B showed no significant difference in IOP with a soft contact lens and without a soft contact lens. Therefore, IOP can be done over soft contact lenses.

It has been shown that measurement of IOP may be influenced by biological variation in corneal thickness, pathological variation in corneal thickness, corneal irregularity, corneal scarring, corneal rigidity, body position and diurnal variation (6). However, these sources of variation were not significant in this study because successive findings on the same eye were made using the same instrument. We also attempted to exclude anyone with known corneal disease or irregularities.

Also, we wished to determine if the power of the contact lens would alter the IOP reading because of a variation in lens thickness. To do this, we divided the data into several groups based on power (see table 3). Once again we performed a statistical analysis and found that the IOP, with soft contacts of various thickness, was not significantly different from the IOP without the contacts on the eye. However, it should be noted that Krieglstein found that IOP readings over soft contact lenses with powers in excess of +8.00 diopters can result in erroneously high IOP values. Due to the lack of hyperopic prescriptions in our study, more investigation is needed to verify Krieglstein's findings.

Conclusion:

Several clinical studies have demonstrated the safety and reliability of the non-contact tonometer. They concur that non-contact tonometry can be successfully and accurately performed in myopic soft contact lens wearers without the need for lens removal (5).

Our study also found that soft contact lenses do not cause a significant difference in the IOP measurement. However, due to the lack of hyperopes in our study we were unable to fully evaluate the effect of contact lens power

and thus thickness on the IOP. It was also determined that manipulation of the eye by applying and removing a soft contact lens did not significantly alter the IOP measurement.

Also, our study indicates that for low and moderate refractive errors, the thickness of the soft contact lens does not seem to alter the IOP measurement. This would indicate that having a soft contact lens on the eye does not cause the variation in IOP measurement that differences in corneal thickness may cause. Klinn Augenheilkd found that for every 0.01mm difference in corneal thickness a 1mmHg difference in IOP resulted. He also stated that this value will vary based on individual corneal tissue quality and is not valid in the presence of corneal edema (1). Dr. Brubaker also looked at the effect of corneal thickness on IOP readings. He concluded that any alteration in corneal thickness will result in a varied IOP measurement (2). Robbin Insler continued this research looking at the effects of contact lens power. This study found that IOP difference was significantly larger for the group with hyperopic lenses than the group with myopic lenses. Charles McMonnies also found that contact lens power was a predictor of IOP accuracy. He found that center thicknesses of 0.15mm or less have no effect on IOP measurements (6). In glaucoma screenings, readings obtained with lenses thicker than 0.15mm may be convenient and useful although such results would be achieved with increased sensitivity and concomitant reduced specificity. Therefore, for clinical purposes the critical limit of 0.15mm center thickness appears to be a satisfactory guide for the acquisition of valid findings (6). A host of others have also looked into this topic with the consensus that corneal thickness can alter IOP readings and in most cases contact lenses are not thick enough to cause an invalid IOP reading.

In conclusion, it appears valid to measure IOP through soft contact lenses. However, in the case of a high hyperopic prescription, it may be necessary to compensate for center thickness of the contact lens.

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