Differences in Noncontact Tonometry With and Without Soft Contact Lenses - Does Power / Center Thickness Make a Difference?

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Introduction

The use of the noncontact tonometer (NCT) has been proven effective and efficient for measurement of the intraocular pressure without applanation to the cornea. Many practices utilize the NCT to reduce "chair" time by allowing the technician or assistant to take IOP (intraocular pressure) measurements prior to the examination. Furthermore, contact lens based practices realize how important exam time is for soft lens follow up patients. Intraocular pressure readings taken while wearing contact lenses saves time by eliminating costly insertion, removal, and stabilization periods.

Pougiales, Jacobson, and Chumley were some of the first to try the technique in the late 1970's using conventional soft lenses.[1] Since the introduction of thinner "disposable" lenses, other studies have investigated readings of different lens designs (i.e. lathed, spin cast), water content, and lens thickness changes. It has been shown that a lens with a center thickness of less than 0.15 mm had no significant difference in pressure readings when compared to readings taken with no lenses at all.[2] Since the center thickness is a major factor, changes in the lens power could affect the center thickness and the NCT results. Insler and Robbins studied the effect of power changes on IOP readings by using thin extended wear myopic (B&L, CSI)and hyperopic (Coopervision) lenses. Their study reported significantly larger IOP readings for hyperopic lenses when compared to readings taken using myopic lenses.[3]

With ever -changing lens types evolving onto the market, we were interested in studying the NCT readings found over a frequently used planned replacement lens. A wide range of powers/ center thicknesses were used to evaluate the accuracy and consistency of the pressure measurements. Several variables can influence the NCT reading over the lens, so we used only one lens type to help reduce any unwanted variables which could be attributed to differences in lens material or design. We chose a common NCT instrument (two AO Reichert II tonometers) and contact lens (Surevue) to help us determine if any significant differences were found when taking NCT readings over different lens powers/ center thicknesses of a commonly used frequent replacement lens.

Methods

Equipment for our undertaking consisted of two major items, the first of which were two AO Reichert II Noncontact Tonometers (NCT). The NCT is a device which can measure intraocular pressure without direct contact of the cornea and without the need for the use of an anesthetic. This device has come into popularity over the past few decades, mostly due to its ease of operation and its ability to be used as an effective screening device of intraocular pressure in today's busy eyecare environment.

The AO NCT works by having the operator align the instrument with the eye and then depress a button, which causes a solenoid driven piston to eject a jet of air toward the cornea. The speed of this so-called "puff" of air increases linearly for 3 msec. and subsequent deformation of the cornea can be detected optically. The time between depression of the button and deformation can be related empirically to the amount of intraocular pressure.[4]

Two separate NCT's of the same model were used in this project in hopes of confirming that the results found were not due to some variability found in a single machine. Each of the NCT's was fully functional and calibrated according to manufacturer's specifications prior to data collection. Calibration was also verified periodically during data collection and no required adjustments were needed on either machine.

The second major component of our project consisted of Surevue soft hydrophilic contact lenses. This brand of contact lenses is recommended to be used as a two week planned replacement lens and was chosen due to its widespread popularity and use in today's contact lens market. According to prepared manufacturer materials, this contact lens is 58% water and 42% etafilcon A polymer (2-hydroxyethyl methacrylate and methacrylic acid crosslinked with 1,1,1-trimethylol propane trimethacrylate and ethylene glycol dimethacrylate). Table 1 consists of a summary of the lens parameters used.

Ten subjects were chosen to participate in the study and all were verified to be free of any anterior segment inflammation or infection. No previous history of glaucomatous or ocular hypertensive symptoms were found in any of the ten patients. All subjects were informed and

instructed on the procedures that were to be performed and all subsequently consented to participation in the study. The ten subjects were then divided into two groups of five, with each group being evaluated on one machine. The pressures of each of the ten subjects was then evaluated without any lenses on and then finally using eight seperate lenses. The manufacturer recommends that successive meaurements be taken in hopes of being able to spot any false or erronously high readings, which could occurr due to examiner or patient error. For our study, we decided to use a series of three readings and then take an average of the three readings in order to obtain a singular IOP measurement.

Each patient was properly placed in a sitting position with their chin in the chin rest and their outer canthus aligned with the black canthus mark on the left upright support of the machine. Each patient was then subjected to a series of three readings on each eye, without wearing a contact lens. Three readings were then taken with the patient wearing each of the eight different powers of contact lenses. An average of ten seconds was allowed between each reading as suggested by the manufacturer. Proper insertion and removal techniques were observed and a minimal amount of time was allotted for lenses to properly settle on the eye.

To prevent any contamination of IOP readings, no data summation was begun until all data was collected.

Results

All data was gathered without complication and summary statistics are featured in Table 2. Table 2 gives us the average differences found between NCT readings without contact lenses compared to those with contact lenses. These averages are broken down into the separate lens powers or center thicknesses. The averages found in Table 2 were computed by first taking an average of the three original IOP readings per eye and per lens. This average IOP reading was then rounded off to the nearest whole number, since AO NCT readings are given in this fashion. The averages of IOP readings taken with lenses on were then compared to readings taken without lenses on. These differences were then compiled for each lens power and then a final average of these five differences was found. This is the average that can be found in Table 2.

The plus/ minus signs in front of select lens powers show that all average readings with contacts were either higher (+) or lower (-) than the average of readings without lenses. Those powers with no sign tell us that there seemed to be no consistent reading of higher or lower when comparing NCT readings with contact lenses versus those readings without contact lenses. Standard deviations and sample variances have also been calculated and included, since they were needed in the calculation of statistical significance.

Analysis of the data seems to show a general trend that as lens power/ thickness increased, the amount of average difference also increased. It is interesting to note that minus lens readings became lower as power/ thickness increased, whereas plus lens readings increased when compared to subjects wearing no lenses. However, according to T-test analysis (p=.950) of all the average differences found, none of these were of any statistical significance.

Discussion

As mentioned earlier, noncontact tonometry has become popular as a screening device of eye pressure, much because of its ease of operation and overall quick nature. When we initially began this paper we felt that if an accurate pressure could be taken over soft contact lenses, we could save more time in office by not having to remove lenses in order to take an IOP reading. In today's managed care world, where time is money, this step could make a small difference in practice management and overall day-to-day operations. The focus of this paper was to determine if lens power/ thickness changes of a common frequent replacement lens would make a difference in NCT readings when compared to readings taken without contact lenses. The answer to this question is a resounding yes .... and no.

First, we will examine the trends found in the minus lenses. In general, NCT readings became lower as lens power/ thickness increased. This trend can be seen in Table 2. Accordingly, it would appear that lens power/ thickness does have some effect on readings taken over contact lenses. However, even though differences were found when wearing lenses, none of the numerical differences were of statistical significance when put to T- test analysis. It must be explained that our statistical analysis was based on information found in the

manufacturer's handout. It states, "An NCT measure is made in a few milliseconds and, because it occurs at random relative to the ocular pulse, one must anticipate a measurement range of 2, 3, or even 4 mm Hg due to the pulse amplitude."[5] Therefore, a limit of 4 mm Hg difference was used as the upper limit of normal when computing statistical significance. Breaking it down into simpler terms, it means that the differences could very well have been due to pulse amplitude and not necessarily due to the presence of a contact lens on the eye; therefore these differences are not statistically significant.

On the other hand, plus lenses did not show similar results when compared to minus lenses. Their averages remained fairly stable as power/ thickness increased. However, the IOP readings taken with plus lenses were generally higher when compared to wearing no lenses at all, and although they were higher, they were still not of any statistical significance.

So what does all this mean? Our study shows that in a small population, using Surevue lenses, lens power/ thickness did have some effect on the readings being taken; however, this difference was not of any significance when compared to manufacturer norms. It must be understood that this study only took into account certain variables and generalizations should not be made concerning the practice of taking NCT readings over contacts. This study did not take into account using different lens materials, lens designs, or very high plus or high minus lenses, which as we know have the greatest center thicknesses of all. As to why minus lenses gave a lower reading and plus lenses gave a higher reading, we can only speculate that this may be due to lens design or possibly differences in the optics of the lenses.

In conclusion, we feel that more study needs to be done in this area before we as optometrists begin to make a practice of taking NCT readings on subject wearing contact lenses. While we have shown that lens power and center thickness do have some effect on readings, a larger sample size would help to confirm this. We also feel that more study needs to be devoted to the other variables of each different lens type before taking NCT readings over contact lenses is instituted as a common practice. And as always, any readings above 20 mmHg should be

viewed with suspicion, investigated without the subject wearing lenses, and preferably evaluated by the use of Goldmann applanation tonometry.

Table 1 Contact Lens Parameters for Vistakon Surevue*

Parameters	Minus Lenses	Plus lenses
1. Power Range	-.50D to -6.00D (in .25D increments) -6.50D to -9.00D (in .50D increments)	+.50D to +6.00D (in .25D increments)
2. Base Curve	8.8 mm, 8.4mm	9.1mm
3. Diameter	14.0mm, 14.0mm	14.4mm
4. Center Thickness Range (varies with power)	.10mm to .16mm	.16mm to .24mm

* Table taken from the Surevue Informational handout - Johnson and Johnson Vision Products, Inc. 1993

Table 2

Contact Lens Power	Average Difference (mm Hg)	Standard Deviation(+/-)	Variance
-.50 sph (8.8)	.6	.82	.92
-1.25 sph (8.8)	-1.2	1.17	1.30
-2.00 sph (8.8)	-.6	.82	.92
-2.50 sph (8.4)	-1.4	1.36	1.51
-4.00 sph (8.8)	-2.2	1.17	1.30
-5.00 sph (8.4)	-2.8	1.94	2.17
-6.50 sph (8.4)	-2.6	.80	.89
-7.00 sph (8.8)	-1.8	.98	1.10
-9.00 sph (8.8)	-4.0	1.41	1.58
-9.00 sph (8.8)	-3.2	.98	1.10
+1.50 sph (9.1)	1.0	.63	.71
+1.50 sph (9.1)	-1.2	1.17	1.30
+3.50 sph (9.1)	+1.2	.75	.84
+3.75 sph (9.1)	+1.8	1.33	1.48
+5.25 sph (9.1)	+1.8	1.17	1.30
+5.50 sph (9.1)	+1.0	.63	.71

References

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4. Brubaker, Richard, Tonometry, Duane's Clinical Ophthalmology (Revised edition 1996) Vol. 3, Ch. 47, page 3.

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