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INFLUENCE OF ARTIFICIAL TEARS ON KERATOMETRIC MEASUREMENTSIN PATIENTS WITH DRY EYE BEFORE CATARACT SURGERY

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ABSTRACT

Purpose: TO assess the effect of artificial tears on K-readings in patients with dry eye prior to cataract surgery. Methods: This prospective before-and-after study included 100 eyes of 58 patients attending the ophthalmological clinic at Tishreen University Hospital between the years 2022-2023. All patients with dry eye and preparing for cataract surgery underwent keratometry measurements. Baseline flat, steep and average keratometry readings were followed by instillation of artificial tears and repeated 2 minutes and 5 minutes after instillation and afterusing the artificial tears 5 times a day for two weeks. **Results:** There was a statistically significant reduction in average keratometric radius measurements obtained after instillation of artificial tears (P<0.01). These differences were most noticeablebetween the baseline measurement and after 2 minutes of the instillation, and reduced over time after 5 minutes, to be noticed again after using the artificial tears 5 times a day for two weeks. The mean variances were (0.12_0.6 _0.11 mm) in sequence prior to instillation. **Conclusion:** Artificial tears have been shown to change keratometric measurements in patients with dry eye who are preparing for cataract surgery. This will affect IOL power, which will eventually have an impact on visual acuity after the surgery. Therefore, it is important to treat dry eye disease before conducting the necessary biological measurements in preparation for the cataract surgery.

KEYWORDS: Cataract, dry eye disease, IOL power, artificial tears, keratometric measurement.

INTRODUCTION

The development in intraocular lens implantation methods and measuring devices have raised expectations for visual outcomes after cataract surgeries. Choosing the appropriate lens measurement is crucial for a good result in uncorrected visual acuity. Corneal curvature measurement affects the measurement of corneal power which is considered a major component in formulae for measuring lens power.

Dry eye disease is one of the most common diseases of the ocular surface, and its symptoms include burning, itching, feeling of a foreign body, as well as blurred vision. It can lead to damage the eye surface and make it irregular, negatively affecting the patient's quality of life.[1,2] The tear film is considered a nourishing and protective medium for the eye surface, in addition to being an important refractive medium for forming a clear retinal image.[3,4]

The approximate prevalence of dry eye disease is 5-50% and increases with age, which correlates with the prevalence of cataract surgery in older individuals. Dry eye causes irregularity of the ocular surface which changes significantly with each blink, resulting in additional aberrations that lead to inaccurate corneal curvature measurements.[5,6]

Artificial tears are currently considered the main treatment for dry eye disease and the first line of defense due to their non-gaseous nature and minimal side effects. They work by adding moisturizing elements similar to those found in natural tears, which helps to increase the thickness and stability of the tear film covering the cornea, prolonging its breakdown timeand protecting the surface of the eye. Artificial tears are also used to improve the regularity of the eye surface and obtain accurate measurements.[7,8,9]

Accurate measurement of corneal power is important in cataract surgery, where it is used informulae to calculate the intraocular lens power (IOL). Dry eye disease is widespread, especially with age, and this is consistent

with the development of cataracts. In our study of medical literature, we found no research on the effect of treating dry eye disease with artificial tears for two weeks on the vital measurements of the cornea. This highlights the importance of our research in studying the short and long term effect of artificial tears on corneal curvature measurements, therefore its strength and the power of the necessary IOL lens in cataract surgery.

MATERIALS AND METHODS

In this study (100 eyes) 58 patients participated, aged between 40-79 years, who attended the ophthalmology clinic at Tishreen University Hospital in Latakia during the period between 2022-2023 and met the inclusion criteria of the study.

Study design
Prospective study.

Duration of the study
13 months between 6/4/2022 and 12/5/2023.

Inclusion criteria
Patients with dry eye disease, aged between 40 and 79 years, who have not undergone any previous surgeries and are scheduled for cataract surgery after obtaining informed consent.

Exclusion criteria
1. Patients with any corneal or conjunctival diseases or abnormalities.
2. Use of any eye drops within the previous 24 hours before the examination.
3. Active eye or nasal allergies.
4. Conjunctivitis or corneal infection.
5. Abnormalities in the nasolacrimal drainage system.
6. Grade 4 dry eye.
7. Any eyelid diseases or deformities.
8. Any previous eye surgeries or trauma.
9. History of contact lens use within the previous 6 months.

METHODS AND MATERIALS

A detailed medical history was taken, including medical and surgical backgrounds, age and gender were recorded. After obtaining informed consent, a comprehensive eye examination was performed, including visual acuity testing and measurement of refractive error. The anterior and posterior segments of the eye were examined using a slit lamp after pupil dilation. Tear film breakup time (BUT) was measured, and a Schirmer test was performed. Based on the DEWS workshop on dry eye syndrome in 2017, dry eye disease was diagnosed when BUT measurement was less than ten seconds or when there was punctate corneal damage with fixation on the cornea.[10] Grade four dry eye disease was excluded accordingto the TFOS DEWS classification.

K-readings were measured for patients with dry eye disease who were undergoing a cataractsurgery obtained by Auto Ref/Keratometer (GR-3500KA). The corneal curvature radius wasrecorded on flat and steep axes, as well as the average curvature radius. The corneal power was also recorded on all the previous axes and the average corneal power, all at consecutive time intervals: before instilling Sodium Hyaluronate artificial tears, and after the instillation for two and five minutes, and after two weeks of using the same artificial tears five times a day, while monitoring improvement by measuring tear film breakup time (BUT) andperforming a Schirmer test.

Afterwards, the IOL power was measured using Quantel Aviso Ultrasound A-scan according to the SRK/T, Holladay, and Hoffer Q formulae after applying local anesthesia and compensating for corneal power measurements on both flat and steep axes previously taken with Auto Ref/Keratometer (GR-3500KA) before instilling Sodium Hyaluronate artificial tears. The lens power was measured again after two and five minutes of instilling the artificialtears and after two weeks of using the same artificial tears five times a day.

Data analysis
All data were evaluated by ophthalmology specialist.
Data were analyzed using IBM SPSS statistics (version 20) software to calculate statistical parameters and analyze the results. Descriptive statistics were used to express quantitative variables using measures of central tendency and measures of dispersion, and qualitative variables using frequencies and percentages. Inferential statistics were used based on statistical laws, including the Friedman test to compare the means of several related populations. The results are statistically significant with a p-value of less than 5%.

RESULTS

The aim of the research was to evaluate the effect of artificial tears on K-readings measurements in patients with dry eye before cataract surgery, as well as the impact of changes in K-readings measurements after instilling artificial tears on the power of the intraocular lens to be implanted in cataract surgeries.

In our study we have included 58 patients, 38 females and 20 males.

The age range of the study participants was between 40 and 79 years, with a mean age of63.74±5.8 years.

Measurement differences in the mean corneal curvature radius
There were statistically significant differences in the mean values of mean corneal radius of curvature, where there was a decrease in values occurred after two minutes of instillation andthe effect was less at five minutes, then returned to values close to those after two minutes of instillation after two weeks. The differences from before the instillation were (0.12-0.6-0.11) respectively with P-value = 0.0001 (Table 1).

Table 1: The mean values of the mean corneal radius of curvature before instillation and its subsequent times were compared among patients referred to the specialized ophthalmology department at Tishreen University Hospital in Lattakia during 2022-2023.

Times	K(mm)	Changes	Range	P-value
Before instillation	7.99±0.1	Re	7.78 – 8.22	0.0001
After 2 minutes	7.87±0.1	- 0.12	7.66 – 8.08	
After 5 minutes	7.93±0.1	- 0.06	7.67 - 8.19	
After 2 weeks	7.88±0.1	- 0.11	7.65 – 8.10	

Measurement differences in the mean corneal powers

There were statistically significant differences in the mean values of mean corneal powers, where there was an increase in values occurred after two minutes of instillation, and the effectwas less pronounced at the fifth minute, followed by a return to values close to those after two minutes of instillation after two weeks. The differences from before the instillation were (0.54-0.27-0.49) respectively with P-value = 0.0001 (Table 2).

Table 2: The mean values of the mean corneal powers before instillation and its subsequent times were compared among patients referred to the specialized ophthalmology department at Tishreen University Hospital in Lattakia during 2022-2023.

Times	K(D)	Changes	Range	P-value
Before instillation	42.32±0.8	Re	41 – 43.50	0.0001
After 2 minutes	42.86±0.8	+ 0.54	41.75 -44	
After 5 minutes	42.59±0.9	+ 0.27	41.25 – 44	
After 2 weeks	42.81±0.8	+ 0.49	41.50 - 44	

Measurement differences in the corneal curvature radius on the flattest axis

There were statistically significant differences in the mean values of corneal radius of curvature on the flattest axis, where there was a decrease in values occurred after two minutesof instillation and the effect was less at five minutes, then returned to values close to those after two minutes of instillation after two weeks. The differences from before the instillation were (0.12-0.06-0.12) respectively with P-value = 0.0001 (Table 3).

Table 3: The mean values of the corneal radius of curvature on the flattest axis before instillation and its subsequent times were compared among patients referred to the specialized ophthalmology department at Tishreen University Hospital in Lattakia during 2022-2023.

Times	K1(mm)	Changes	Range	P-value
Before instillation	8.04±0.1	Re	7.84 – 8.35	0.0001
After 2 minutes	7.92±0.1	- 0.12	7.69 – 8.17	
After 5 minutes	7.98±0.1	- 0.06	7.74 – 8.33	
After 2 weeks	7.92±0.1	- 0.12	7.70 – 8.17	

Measurement differences in corneal powers on the flattest axis

There were statistically significant differences in the mean values of corneal powers on the flattest axis, where there was an increase in values occurred after two minutes of instillation,and the effect was less pronounced at the fifth minute, followed by a return to values close to those after two minutes of instillation after two weeks. The differences from before the instillation were (0.64-0.34-0.61) respectively with P-value = 0.0001 (Table 4).

Table 4: The mean values of corneal powers on the flattest axis before instillation and itssubsequent times were compared among patients referred to the specialized ophthalmology department at Tishreen University Hospital in Lattakia during 2022- 2023.

Times	K1(D)	Changes	Range	P-value
Before instillation	41.98±0.8	Re	40.50 – 43	0.0001
After 2 minutes	42.62±0.8	+ 0.64	41.25 – 43.75	
After 5 minutes	42.32±0.9	+ 0.34	40.50 – 43.50	
After 2 weeks	42.59±0.8	+ 0.61	41.25 – 43.75	

Measurement differences in the corneal curvature radius on the steepest axis

There were statistically significant differences in the mean values of corneal radius of curvature on the steepest axis, where there was a decrease in values occurred after two minutes of instillation and the effect

was less at five minutes, then returned to values close to those after two minutes of instillation after two weeks. The differences from before the instillation were (0.11-0.06-0.10) respectively with P-value = 0.0001 (Table 5).

Table 5: The mean values of the corneal radius of curvature on the steepest axis before instillation and its subsequent times were compared among patients referred to the specialized ophthalmology department at Tishreen University Hospital in Lattakia during 2022-2023.

Times	K2(mm)	Changes	Range	P-value
Before instillation	7.94±0.1	Re	7.69 – 8.20	0.0001
After 2 minutes	7.83±0.1	- 0.11	7.60 – 8.08	
After 5 minutes	7.88±0.1	- 0.06	7.55 – 8.21	
After 2 weeks	7.84±0.1	- 0.10	7.61 – 8.14	

Measurement differences in corneal powers on the steepest axis

There were statistically significant differences in the mean values of corneal powers on the steepest axis, where there was an increase in values occurred after two minutes of instillation,and the effect was less pronounced at the fifth minute, followed by a return to values close to those after two minutes of instillation after two weeks. The differences from before the instillation were (0.59-0.27-0.51) respectively with P-value = 0.0001 (Table 6).

Table 6: The mean values of corneal powers on the steepest axis before instillation andits subsequent times were compared among patients referred to the specialized ophthalmology department at Tishreen University Hospital in Lattakia during 2022- 2023.

Times	K2(D)	Changes	Range	P-value
Before instillation	42.53±0.8	Re	41.25 – 43.75	0.0001
After 2 minutes	43.12±0.9	+ 0.59	41.75 – 44.50	
After 5 minutes	42.80±0.9	+ 0.27	41.25 – 44.25	
After 2 weeks	43.04±0.9	+ 0.51	41.50 – 44.50	

Measurement differences in the IOL power according to SRK/T formula:

There were statistically significant differences in the mean values of IOL power according to SRK/T formula, where there was a decrease in values occurred after two minutes of instillation and the effect was less at five minutes, then returned to values close to those aftertwo minutes of instillation after two weeks. The differences from before the instillation were (0.76-0.40-0.73) respectively with P-value = 0.004 (Table 7).

Table 7: The mean values of IOL power according to SRK/T formula before instillation and its subsequent times were compared among patients referred to the specialized ophthalmology department at Tishreen University Hospital in Lattakia during 2022- 2023.

Times	SRK/T	Changes	Range	P-value
Before instillation	21.36±2.1	Re	17 – 24.50	0.004
After 2 minutes	20.60±2.1	- 0.76	16.50 – 24	
After 5 minutes	20.96±2.06	- 0.40	17 – 24	
After 2 weeks	20.63±2.08	- 0.73	16.50 – 24	

Measurement differences in the IOL power according to Holladay formula

There were statistically significant differences in the mean values of IOL power according to Holladay formula, where there was a decrease in values occurred after two minutes of instillation and the effect was less at five minutes, then returned to values close to those after two minutes of instillation after two weeks. The differences from before the instillation were (0.79-0.43-0.76) respectively with P-value = 0.02 (Table 8).

Table 8: The mean values of IOL power according to Holladay formula before instillation and its subsequent times were compared among patients referred to the specialized ophthalmology department at Tishreen University Hospital in Lattakiaduring 2022-2023.

Times	Holladay	Changes	Range	P-value
Before instillation	21.49±2.1	Re	17 – 24.50	0.02
After 2 minutes	20.70±2.1	- 0.79	16.50 – 24	
After 5 minutes	21.06±2.04	- 0.43	17 – 24	
After 2 weeks	20.73±2.1	- 0.76	16.50 - 24	

Measurement differences in the IOL power according to Hoffer Q formula

There were statistically significant differences in the mean values of IOL power according to Hoffer Q formula, where there was a decrease in values occurred after two minutes of instillation and the effect was less at five minutes, then returned to values close to those after two minutes of instillation after two weeks. The differences from before the instillation were (0.83-0.43-0.79) respectively with P-value = 0.006 (Table 9).

Table 9: The mean values of IOL power according to Hoffer Q formula before instillation and its subsequent times were compared among patients referred to the specialized ophthalmology department at Tishreen University Hospital in Lattakiaduring 2022-2023.

Times	Hoffer Q	Changes	Range	P-value
Before instillation	21.49±2.1	Re	17 – 24.50	0.006
After 2 minutes	20.66±2.1	- 0.83	16.50 – 24	
After 5 minutes	21.06±2.04	- 0.43	17 – 24	
After 2 weeks	20.70±2.1	- 0.79	16.50 - 24	

DISCUSSION

When the patient suffers from instability of the tear film, he will suffer from many disturbing symptoms, such as burning and blurred vision, and this may be caused by the irregularity of the corneal surface and the lack of corrected visual ability, and all of these are signs of dry eye.[11] Dry eye disease may limit the desired outcome after cataract operations. Several studies have suggested paying attention to the presence of dry eye when planning cataract surgery, as it may affect wound healing, leading to a change in the resulting refractive power.[12] In addition, the validity and reliability of the measurements of the devices used to prepare for cataract surgery depend on the regularity of the corneal surface and a stable tear film. Therefore, it was necessary to achieve a stable tear film and regularity of corneal surface before cataract surgery could be performed.[12]

In our study, sodium hyaluronate (Hyloram 0.4%)® eye drop was used as a treatment for dryeye disease, which is the salt form of hyaluronic acid. Its advantages are that it increases the stability of the tear film covering the cornea, does not alter the normal conjunctival epithelium, does not interfere with the production of goblet cells, and does not damage intracellular connections.[12]

We found statistically significant differences in corneal curvature measurements before and after 2 minutes of instilling artificial tears at consecutive time points. The measurements of corneal curvature radis after instillation were 0.11 mm, 0.12 mm, and 0.12 mm less than the measurements before instillation on the steepest and flattest axes and the mean radius, respectively. This decrease in corneal curvature radius measurements led to an increase in corneal power measurements after 2 minutes instillation compared to before instillation by 0.58 D, 0.64 D, and 0.54 D on the steepest and flattest meridians and the mean power, respectively. This resulted in a statistically significant difference in lens power calculation for intraocular lens implantation using the SRK/T, Holladay, and Hoffer Q formulas, where the difference was 0.76 D, 0.79 D, and 0.83 D, respectively. This difference is clinically significant as it exceeds 0.5 D, which represents the difference between commercially available lens powers.

Then, corneal curvature measurements started to increase on all axes as time progressed, withthe difference after 5 minutes of instillation being 0.6 mm on all axes. Consequently, corneal power measurements decreased on all axes after 5 minutes of instillation, with differences of 0.27, 0.35, and 0.27 diopters, respectively. Lens power increased again, with differences of 0.40 diopters using the SRK/T formula, 0.43 diopters using the Holladay formula, and 0.43 diopters using the Hoffer Q formula.

After treating dry eye disease with Sodium Hyaluronate artificial tears five times a day for two weeks, we noticed a decrease in corneal curvature measurements on all axes, with differences from before instillation of 0.10, 0.12, and 0.11 mm, respectively. Corneal power measurements also increased on all axes, with differences from before instillation of 0.51, 0.61, and 0.49 diopters, respectively. The intraocular lens power also decreased, with differences from before instillation of 0.73 diopters using the SRK/T formula, 0.76 diopters using the Holladay formula, and 0.79 diopters using the Hoffer Q formula. As previously mentioned, this difference is clinically significant as it exceeds 0.5 diopters.

These changes can be explained by the fact that the devices used to perform biometrics corneal measurements for cataract surgery preparation rely on a stable tear film and a regularcorneal surface.[13]

Our study results were consistent with the findings of (Veronika R et al, 2020),[13] which also reported significant changes in corneal curvature measurements after instillation of artificial tears for two minutes, as well as changes in the IOL power. However, our results differed from those of (Nan C et al, 2021),[12] who did not find a significant effect on corneal curvature measurements except for a temporary effect lasting for ten minutes after using sodium hyaluronate eye drops at a concentration of 0.1%. This difference could be due to

the difference in the concentration of the eye drops used, as well as the duration of follow-up after using the drops.

Our results also differed from those of (Somporn C et al, 2018),[14] who divided the patients into two groups: those with dry eye disease and a control group. All measurements were taken using the VERION image-guided system, which uses diodes emitted from light focused on the corneal surface to determine its measurements.They did not observe statistically significant differences in corneal curvature and lens power measurements after instillation of (Cellufresh MD 0.5%)® artificial tears by 5 minutes and 30 minutes in patients with dry eye disease compared to controls. This difference from our study could be due to the differences in the devices used for measurements, the viscosity and type of artificial tears used, and the sample size, which was larger in our study.

However, our results matched the outcomes of (Xu H et al, 2021),[15] as they found significant statistical differences in corneal curvature measurements taken after instilling artificial tears in patients with dry eye disease compared to a control group. Additionally, wedid not find any studies in the medical literature that evaluated the effect of treatment with artificial tears for two weeks with a specific frequency on corneal curvature and the power of the lens implanted in the eye in patients with dry eye disease before cataract surgery.

In conclusion, our study demonstrated significant changes in corneal curvature and lens power measurements after using Sodium Hyaluronate artificial tears for two weeks in patients with dry eye disease. These findings highlight the importance of considering the effects of artificial tears on corneal measurements when preparing for cataract surgery.

CONCLUSION

Artificial tear drops have an important effect on measuring corneal curvatures in patients with dry eyes before cataract operations, as they decrease the radius of these curvatures on the flattest and steepest axis and the average measurement of the curvature, thus give greater corneal power and a lesser measurement of the required intraocular lens power. This difference is important in clinical practice and affects the expected visual ability after cataractsurgery.

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