# Article • Effect of Artificial Tear Supplements on Vision

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B. Optom: Rajiv Gandhi University of Health Sciences, Bangalore, India 2017

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ABSTRACT

**Background:** Artificial tear supplementation is the first-line treatment in dry eye disease (DED) and many other ocular disease conditions. Some clinicians prefer drops, while others choose gels to help their patients. It is observed that patients complain of decreased vision with gel but improved performance with drops. This study was carried out to compare visual acuity (VA) and contrast sensitivity (CS) before and after instillation of artificial tear drops and tear gels.

**Methods:** A prospective study was performed using 60 subjects (120 eyes). Tear film status was checked by doing tear breakup time (TBUT) and the Schirmer test. Subjects having previously diagnosed dry eyes were not included in the study. VA and CS were assessed pre- and post-instillation of artificial tear drop and tear gel.

**Results:** The mean VAs pre- and post-instillation of the tear drop were 0.0168 ± 0.1993 LogMAR and 0.0090 ± 0.2126 LogMAR, respectively (z=-0.4287, p=0.3341), which were statistically insignificant. VA after the instillation of tear gel was significantly decreased, with mean values of 0.1600 ± 0.1839 LogMAR (z=9.6, p<0.000). CS values pre- and post-instillation of the tear drop were 1.7813 ± 0.1466 and 1.7638 ± 0.1411 (z=-1.307, p=0.9045), respectively, which were statistically insignificant. CS after tear gel reduced significantly, with a mean value of 1.6887 ± 0.1533 (z=-6.97, p<0.0001). The tear film status between males and females were not significant, both quantitatively (Schirmer's test) and qualitatively (TBUT) (z =-0.2148, p=0.8299 and z=-0.7723, p=0.4399).

**Conclusion:** VA and CS remain the same after instillation of tear drops, allowing use at any time of the day. Artificial tear gel decreased visual function. For those who require fine visual functions (VA and CS), tear gel is not a good option for daytime treatment.

**Keywords:** artificial tear drop, artificial tear gel, contrast sensitivity, visual acuity, visual performance

## Introduction

Dry eye disease (DED) is a multifactorial disease of the tears and the ocular surface that results in discomfort, visual disturbance, and tear film instability, with potential damage to the ocular surface.[1] Prevalence of dry eye ranges from 5% to 35% worldwide, while in India, the prevalence is 29.25% based on Ocular Surface Disorder Index (OSDI) data.[2] Artificial tears and gel are the preferred modes of treatment. Polymer-based artificial tears are frequently used in dry eye treatment.

In addition to dry eye, artificial tear supplements are used in the treatment of various ocular conditions, such as corneal abrasions, ultraviolet keratitis, herpes simplex and zoster keratitis, giant papillary conjunctivitis, superior limbic keratoconjunctivitis, vernal disease, adenoviral infections, and other ocular surface conditions. The ideal artificial tear would reproduce the metabolic, optical, and physical characteristics of natural tears. Artificial tear supplementation should in theory have a long ocular residence time and contain therapeutic additives to treat primary and secondary damage to the ocular structures.[3] Supplementation of artificial tears with a substance that prolongs residence time generally improves tear film breakup time (TBUT) and is superior to tear replacement fluids of low retention time.[3] Most artificial tear formulations are water-based, with polymers added to enhance viscosity, lubrication, and retention time in order to promote tear film stability. Sodium chloride, potassium chloride, various other ions, and boric acid help to maintain tonicity and pH similar to normal tear film.[3]

Ridder conducted a study to investigate how different formulations of carboxymethylcellulose

sodium (CMC) affects contrast sensitivity for spectacle wearers or when applied over soft and rigid gas-permeable contact lenses. The study found that Liquigel or Celluvisc significantly decreased contrast sensitivity.[4]

Zhang et al. measured the effect of different artificial tears on CS in Sjogren's syndrome patients (from 5 minutes to 4 hours after instillation). They showed that the effect of artificial tears on CS in the post-instillation period appears limited, but an artificial tear with more mucoadhesive properties showed more benefit. CS was decreased just after installation of the drop (within 1 sec) and it increased over time.[5]

Ridder and Tomlinson determined that artificial tears stabilize the tear film and improve visual performance in contact lens wearers who also exhibit dry eye. They found that there is benefit to the person with dry eyes because with tear drops, there will be minimum disruption of the tear layer.[6]

Hall Jr. et al. observed the relationship between the visual effects and the residence time of artificial tears in dry eye subjects. Visual effects and residence time were measured after the administration of artificial tears in 25 patients. The visual effects were investigated by measuring CS before and after artificial tear administration. The return to baseline CS was taken as the time it took to return to within 1 standard deviation of baseline. Residence time was measured using fluorescent formulations and a scanning fluorometer. No correlation was found between return to baseline CS and residence time for a low-viscosity drop. There was a significant difference in residence time for the high-viscosity drop.[7]

Paugh et al. investigated the precorneal residence time of saline and five marketed artificial tears in dry eye subjects using fluorometry. All subjects were classified as having non-inflammatory meibomian gland dysfunction except one, who had a mixture of aqueous deficiency and meibomian gland dysfunction. More than two-fold residence time differences were found for the higher-viscosity and more muco-adhesive formulations compared to saline. However, other formulations provided residence time close to saline, suggesting that residence time is influenced by factors other than simple viscosity.[8]

Maharana et al. compared the efficacy of carboxymethylcellulose 0.5%, hydroxypropyl-guar containing polyethylene glycol 400/propylene glycol (PEG/PG), and hydroxypropyl methylcellulose 0.3% (HPMC) as tear substitutes in patients with dry eye. Patients presenting with dry eye symptoms were evaluated retrospectively. They concluded that hydroxypropyl-guar containing PEG/PG and HPMC as tear substitutes were better than CMC. HPMC was comparable to PEG/PG in subjective improvement, while the objective improvement was not consistent.[9]

## Methodology

This cross-sectional study included 120 eyes of 60 subjects from Sankara College of Optometry (SCO), Bangalore, India. Parental consent was obtained for the subjects less than 18 years of age. Written consents were taken from the subjects after providing basic information about the project. Individuals between the ages of 15 and 40 were included in the study. Optometric clinical examination consisted of the following tests:

Visual Acuity: Vision assessment was done by using the LogMAR visual acuity chart at 4 meters. Only monocular distance vision was taken. Both pre and post VA was taken with the habitual spectacle correction. Contact lens users were not included in the study.

Contrast sensitivity: Monocular contrast sensitivity was taken using the Pelli-Robson CS chart at 1 meter with the habitual spectacle correction. When subjects answered incorrectly for two letters among a group of three letters, previous values were recorded as CS value.

Tear Film Break Up Time (TBUT): TBUT was taken monocularly. This study considered <5 seconds as dry eye.[10] After TBUT, there was a 10 minute gap, and then the Schirmer II test was done.

Schirmer II Test: One drop of anaesthetic agent (proparacaine) was instilled to decrease reflex tear secretion, and values were recorded in mm within 5 minutes. Values of 10 mm or greater in 5 minutes were considered as normal, 5 to 10 mm was considered as mild dry eye, 2 to 5 mm was moderate dry eye, and <2 mm was considered as severe dry eye.[2]

Subjects having normal TBUT values and normal Schirmer II test values were included in the study. Subjects suffering from dry eye were not included in the study. Subjects were given one drop of artificial tears in each eye. Within 3 to 5 minutes, VA and CS were assessed monocularly. After 20 minutes, tear gel was applied. VA and CS were taken within 3 to 5 minutes in the same fashion.

Different LogMAR VA charts and Pelli-Robson CS charts were used for each test to overcome the chance of memorization. The external environmental condition (room illumination) was same throughout the study. Data entry was done in SPSS Version 23

**Table 1. Comparison of VA Before and After Instillation of Tear Drop and Tear Gel**

| Time | Mean (LogMAR) | SD | Z test | P value |
|---|---|---|---|---|
| Before instillation of drop | 0.0168 | 0.1993 | -0.4287 | 0.3341 |
| After instillation of drop | 0.0090 | 0.2126 | | |
| Before instillation of gel | 0.0168 | 0.1993 | 9.6848 | <0.0001 |
| After instillation of gel | 0.1930 | 0.1839 | | |

**Table 2. Comparison of CS Before and After Instillation of Tear Drop and Tear Gel**

| Time | Mean CS Value | SD | Z test | P value |
|---|---|---|---|---|
| Before instillation of drop | 1.7813 | 0.1466 | -1.3077 | 0.9045 |
| After instillation of drop | 1.7638 | 0.1411 | | |
| Before instillation of gel | 1.7813 | 0.1466 | -6.9700 | <0.0001 |
| After instillation of gel | 1.6887 | 0.1533 | | |

software, and data analysis was done by using the z-test to see the effect of artificial tear drops and tear gel on VA and CS.

## Results

A total of 120 eyes in 60 subjects ranging from 17 to 26 years (mean age 20.60, SD 2.36) was evaluated. Among them, 25 (41.7%) were female and 35 (58.3%) were male.

Table 1 shows that the change in VA following the instillation of the tear drop was statistically insignificant (p=0.3341). VA following the instillation of the tear gel was statistically significant (p<0.0001).

Table 2 shows that the change in CS following the instillation of the tear drop was statistically insignificant (p=0.9045). CS following the instillation of the tear gel was statistically significant (p<0.0001).

Figure 1 shows that the difference between TBUT values for male and female subjects was statistically insignificant (p=0.4399).

Table 3 shows that the difference between Schirmer test results for male and female subjects was statistically insignificant (p=0.8299).

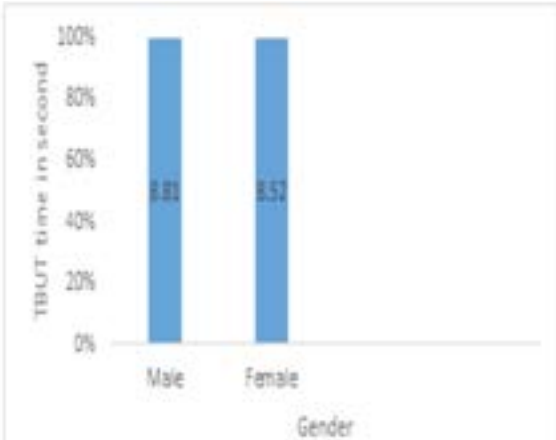


***Figure 1.*** *Comparison of TBUT between male and female subjects*

## Discussion

The purpose of this study was to determine whether the administration of artificial tear drops or tear gel would alter visual performance. VA and CS remained the same after supplementation with the tear drop, but VA and CS were significantly decreased after application of the artificial tear gel.

The application of less viscous artificial tears (e.g., HPMC tear drop 0.3%) to the tear layer does not disrupt the tear layer. It helps to make the surface smoother so that light does not scatter from the ocular surface, leading to a slight increase in visual performance after instillation. Artificial tear gel (HPMC 2% gel) is highly viscous compared to the tear. Because of its viscous nature, in short term use, it may initially disrupt the tear layer, and sometimes scattering of light rays can take place. As a result, there was a decrease shown in visual performance (VA and CS) for a short time, but in subjects with an evaporative dry eye, aqueous supplementation may be all that is necessary to improve visual performance in the long term.

For many patients with dry eye, artificial tears with higher viscosity, or gel-type tears, are preferred for their extended efficacy due to enhanced ocular residence.[11,12] In addition, these mid-viscosity gel-type tears are more suitable for night-time than conventional tears. Overall, the more viscous gel-

**Table 3. Comparison of Schirmer Test Values Between Male and Female Subjects**

| Gender | Mean Schirmer (mm) | SD | Z test | P value |
|---|---|---|---|---|
| M | 23.1142 | 10.7157 | -0.2148 | 0.8299 |
| F | 22.900 | 9.4916 | | |

type artificial tears are associated with greater improvement in signs and symptoms of dry eye compared with standard low-viscosity lubricating eye drops.[13-15] If viscosity is too high, it may reduce tolerability due to blur, stickiness, and build-up of residue on the lids and lashes. However, it is also essential that sufficient viscosity is retained under shear stress (during blinking) in order to maintain ocular residence.[16]

In this study, assessment of the effect of artificial tear solutions followed limited application (a single drop, one time). The subjects did not use the eye drops for a prolonged period. Such studies of the acute effects of drop application will not reveal any long-term impacts of the solution on the tear film, which can result from frequent application over a period of therapy. Thus, the results may have been different if the subjects had used the drops or gel for several weeks before testing.

**Future scope**

Given that this study assessed the effect of artificial tear solutions following limited application, the study should be repeated with prolonged use of tear supplements. A future study could also assess the tear film status objectively. Another study could be carried out with subjects diagnosed with dry eye disease, which may produce different results. Sample size could be increased, and the study should be done in a larger population to find more accurate results.

## Conclusion

VA and CS remain the same after the instillation of a tear drop, so for any type of ocular condition where visual demand is very important, tear drops can be prescribed at any time of the day. Artificial tear gel severely decreased visual function; for those who require fine visual functions (VA and CS), tear gel is not a good option for daytime treatment.

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Dhakal KP. Effect of artificial tear supplements on vision. Optom Vis Perf 2020;8(4):192-5.