



EFFECT OF CARBOXYMETHYLCELLULOSE AS LUBRICATING AGENT ON DRY EYE

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ABSTRACT

Dry eye disease nowadays becomes a most common ocular disease which can be treated by the application of artificial tears [carboxymethylcellulose (CMC)] which hydrate and lubricate the ocular surface. **Aims and objective:** To study effect of CMC as lubricating agent on dry eye. **Materials and methods:** A total of 100 patients diagnosed with dry eye were enrolled in the study period of 6 month. Patients were stabilized with CMC and were followed up on 2 weeks and 4 weeks. Diagnostic test includes Schirmer's test. Analysis was done by t-test; $p < 0.05$ was considered significant. **Results:** The population sample consists of 100 patients, 74 females and 26 males, among them most of the patients were in 20-30 year age groups and number of female was higher in all age group but in 50-60 year age groups, both males and females are equal number. The higher numbers of patients were found to be housewife (55%). Both eyes were tested with the schirmer strips and value ranged from 3 mm to 35 mm in right eye and 1 to 35 mm to left eye. The effect after 2 weeks of treatment in compared to 0 week is found to be improved but not significant while after 4 weeks of treatment, the effect was significant with the mean higher than 10 mm with p -value < 0.05 . **Conclusion:** The result shows a significant beneficial effect after frequent application of 0.5% isotonic solution of CMC to improve clinical symptoms (blurry vision, ocular dryness, foreign body sensation and burning sensation) of dry eye.

KEYWORDS: Artificial tears, Carboxymethylcellulose, Dry eye, Schirmer's test.

INTRODUCTION

The eye is one of the multiplex organs of the human body which composed of three layers i.e. outer, middle and inner. The outer layer consists of cornea and sclera which connected at the limbus. The middle layer of eye is composed of iris, ciliary body and choroid. The inner layer of an eye is retina.^[1] Dry eye is a multifactorial disease of the tears and ocular surface that results in symptoms of discomfort, visual disturbance, and tears film instability with potential damage to the ocular surface. It is accompanied by increased osmolarity of the tear film and inflammation of the ocular surface.^[2] Dry eye disease (DED) is also called Keratoconjunctivitis Sicca (KCS), Keratitis sicca, Sicca syndrome, Xerophthalmia, Dry eye syndrome (DES), Ocular surface disease (OSD), Dysfunctional tear syndrome (DTS) or simply dry eye. Keratoconjunctivitis Sicca is Latin word where keratoconjunctivitis means dryness of cornea and conjunctiva and sicca means desiccate. The condition in which eye do not produce sufficient tear is known as sjogren's syndrome.^[3] The common causes of dry eye include wind, sun, heating air conditioning, use of computer cell phone and certain medications. The main causes for DES are decreased tear production,

excessive tear evaporation and abnormality in production of mucus or lipid of tear layers.^[4] Various factors like age, female sex, systemic autoimmune disease, lifestyle influences, hormonal fluctuations, Meibomian gland atrophy, contact lens use, and refractive surgery have been identified as key players.^[5] The prevalence of dry eye symptoms increases with age and has been reported to approximately 5% to 35% of the study population depending on the criteria used to define the condition and the differences in the definition of the study population.^[6] The prime goal of treatment of the ocular surface disorders includes relief of symptoms, improvement of visual acuity and quality of life, restoration of ocular surface and tear film, and correction of underlying defects. Treatment options comprise of hygiene and life style changes, artificial or autologous serum tear use, and anti-inflammatory drug therapy, as well as physical and surgical procedures to increase tear retention. Treatment should be adjusted to incorporate the patient's response and must maintain a balance between efficacy, safety, and patient convenience.^[7] The simplest and most effective way to relieve symptoms of dry eye is a lifestyle change. Patients should be advised to avoid long exposure to computers, TV, and reading

which is associated with a reduced blink rate and thus increased evaporation. The use of artificial tears and short breaks during these activities are recommended. Humidification of air in the home and work place could also alleviate undesirable effects. Avoidance of hot, windy, low-humidity, and high altitude environments as well as smog and smoke is also advisable.^[7,8] Eyelid hygiene, warm compresses, and topical antibiotics when needed are essential for chronic blepharitis and meibomian gland dysfunction treatment which can be associated with tear dysfunction. These measures reduce bacterial induced changes in the lipid component of the tear film, which in turn reduces evaporative tear loss.^[8] Although there are many lubricating agents for dry eye treatment, carboxymethylcellulose (CMC) mainly containing sodium is highly preferable. Dryness of eye is commonly tested by Schirmer's test, where schirmer level below 10 mm is categorized as dry eye syndrome. Thus, the aim was to observe the lubricating effect of CMC in dry eye.

METHODS AND MATERIALS

Study design

This was a prospective observational hospital based study.

Study site

The study was conducted at Shree Rana Ambika Shah Eye Hospital, Bhairahawa, Rupandehi, Nepal.

Study period

The study was conducted for 6 month from 1st June to 1st December 2017.

Study population

A total of 100 patients were included in the study.

Inclusion criteria

1. Patients of any sex will be included in the study.
2. Patients prescribed with only carboxymethylcellulose will be included in the study.

Exclusion criteria

1. Pregnant women will be excluded from the study.
2. Patients below age of 16 year will be excluded from the study.

RESULTS

During the study period we collected a total of 100 patient's prescriptions as per inclusion criteria.

Table 3: Follow up of DED patients during treatment.

Gender	Weeks					
	0 Week		2 Weeks		4 Weeks	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Males	26	26	19	23.2	18	22.8
Females	74	74	63	76.8	61	77.2
Total	100	100	82	100	79	100

Age and gender distribution of patients

The study population consists of 100 patients, 74 females and 26 males, resulting in 200 eyes being examined. The age of the patients ranged from 17 to 72 years with a mean of 34.27 ± 12.29 years and mode of 30 years. The ages of females ranged from 17 to 70 years with a mean of 33.85 ± 11.69 years and mode of 28 years. The ages of males ranged from 18 to 72 years with a mean of 33.85 ± 14.02 years and mode of 30 years. The number of female and male patients in each group is shown in table 1. Most of the patients were in the 20-30 year age groups and the number of females was higher in all age groups but in age group of 50-60 years, both males and females are in equal number. Male to female ration was 1:2.85.

Table 1: Age of male and female patients.

Age Interval	Gender		Total
	Male	Female	
Below 20	3	7	10
20 – 29	9	28	37
30 – 39	6	24	30
40 – 49	4	10	14
50 – 59	3	3	6
60 – 70	0	2	2
Above 70	1	0	1
Total	26	74	100

Occupation wise distribution of DED patients

DED patients can be distributed according to occupation status as shown in table 2. Among the total number of patients with mean 1.93 and SD 1.174, higher numbers of patients were found to be housewife (55%).

Table 2: Occupational distribution of DED patients.

Occupation	Frequency	Percent
House Wife	55	55.0
Farmer	14	14.0
Student	14	14.0
Employee	17	17.0
Total	100	100.0

Follow up of DED patients during treatment

The total number of patients was 100 in 0 weeks which were suggested to follow up after 2 weeks and 4 weeks. The detail information regarding follow up data is shown in table 3. In our study, numbers of patients (both males and females) from the total of 100 were significantly in decreasing order in 2 weeks and 4 weeks respectively where females are in higher number and then followed by males.

Tear quantity assessment: Schirmer 3 test (4 weeks of treatment)

Both eyes were tested with the schirmer strips and schirmer test values ranged from 3 mm to 35 mm for the

right eyes, and 1 mm to 35 mm to the left eyes. The ranges, means and standard deviation are shown in table 4.

Table 4: Descriptive details showing the number of eyes, range, mean and standard deviation of the schirmer 3 values for the followed up patients.

Eyes	Number	Range (mm)	Mean	Standard deviation
All participants				
Right Eye	79	3-35	16.01	11.25
Left Eye	79	1-35	16.54	11.11
Both Eye	158	1-35	16.25	10.80
Males				
Right Eye	18	3-35	15.67	10.89
Left Eye	18	4-35	16.67	10.74
Both Eye	36	3-35	16.17	10.44
Females				
Right Eye	61	3-35	16.11	11.44
Left Eye	61	1-35	16.50	11.29
Both Eye	122	1-35	16.30	10.99

An effectiveness analysis by t- test

This analysis of the data includes: paired t-test and single t-test.

Paired t-test

This test includes analysis of efficacy: before treatment with treatment followed up 2 weeks and 4 weeks respectively.

Table 5: Analysis of efficacy of before treatment with treatment on followed up 2 weeks and 4 weeks respectively.

	0 Week – 2 Weeks		0 Week – 4 Weeks	
	Eyes		Eyes	
	Right	Left	Right	Left
	R0 – R2	L0 – L2	R0 – R4	L0 – L4
Mean	4.9293 – 8.8293	4.9390 – 8.8731	4.7241 – 16.0127	4.9794 – 16.5443
P-value	5.1×10^{-5}	4.3×10^{-6}	1.3×10^{-15}	4×10^{-17}

In our study, the effect after 2 weeks of treatment in compared to 0 week is found to be improved but was not significant. While after 4 weeks of treatment, the effect was significant with the mean higher than 10 mm and $p < 0.05$.

Single t-test: This test includes analysis of efficacy on treatment after 2 weeks and treatment after 4 weeks.

Table 6: Analysis of efficacy of treatment after 2 weeks and 4 weeks.

	0 Week – 2 Weeks		0 Week – 4 Weeks	
	Eyes		Eyes	
	Right	Left	Right	Left
	Mean	8.8293	8.8731	16.0127
P-value	1.2591×10^{-16}	1.0092×10^{-22}	1.4066×10^{-20}	1.2017×10^{-21}

In our study, efficacy results on 2 weeks and 4 weeks were found improved. The DES is improved on treatment after 2 weeks but was not significant as mean value was found below 10 mm with $p < 0.05$. But on treatment after 4 weeks, the result of effectiveness was found to be significant.

Eye Workshop (DEWS) report considered tear instability and hyperosmolarity to be core mechanism of dry eye suggesting that tear instability leads to hyperosmolar conditions and inflammation resulting in dry eye symptoms.^[9]

DISCUSSION

Dry Eye a common condition affecting millions, is characterized by symptoms of ocular discomfort, dryness, irritation and visual disturbance. The 2007 Dry

In general, the DES is treated with artificial tear or tear conservation technique, with varying degree of success.^[10] It is assumed that an ideal tear substituent for treating DES should have some essential characteristics. The CMC solution utilized in this study has an

electrolytic composition similar to that of the human tear. Since the solution is isotonic, it can surely contribute to correct osmolarity and pH distortions generally observed in DES.^[11]

In our study, patients of all age (except < 17) were randomly selected. Majority of patients were in the age group of 20-30. Our research was supported by the study carried out by (Khan 2012) where majority of patients were in the 18-21 age groups.^[12]

Females are more prone to males because menopause bring hormonal shift. Women's Health Initiative study showed that at least 60% of peri- and post-menopausal women experience symptoms of dry eye.^[13] Our study also support the above mentioned fact where out of 100 patients, females (74%) were found to be more prone to DES than males (26%).

The majority of the patients (55%) in our study were housewife which was followed by employee (17%), both farmer and student with (14%) respectively. Unfortunately we were unable to find any related study to support our result.

To determine how dry the eyes are, the tear production should be measured with the help of schirmer strips which is known as schirmer test. On the 2 weeks and 4 weeks of treatment the schirmer test was carried out. In this study the 2 weeks of treatment was improved but was not significant while on the 4 weeks of treatment the result was significantly effective with the following information: The schirmer tear test value for all 79 patients ranged from 1.00mm to 35.00mm with a mean of 16.25 and SD of 10.8. The schirmer tear test 3 values for the males varied from 3.00mm to 35.00mm with a mean of 16.17 and SD of 10.44. The schirmer tear test 3 values for the females varied from 1.00mm to 35.00mm with a mean of 16.30 and SD of 10.99.

To test whether the treatment was effective or not, the data was analyzed by paired t-test and single t-test. For this, following hypothesis was set up.

H_0 : treatment is not significant

H_1 : treatment is significant if the schirmer level is higher than 10.00 mm ($\mu > 10.00$ mm)

In our study, the data from paired t-test were analyzed as the mean value for right eye in 0 week and 2 weeks was 4.9293 and 8.8293 respectively with the p-value 5.1×10^{-5} while for the left eye the mean value was 4.9390 and 8.7317 respectively with the p-value 4.3×10^{-6} . This shows that treatment was improved but was not significant as the mean value lies below 10.00 mm. However, the mean value for right eye in 0 week and 4 weeks was 4.7241 and 16.0127 respectively with the p-value 1.3×10^{-15} while for the left eye the mean value was 4.9794 and 16.5443 respectively with the p-value 4×10^{-17} . This shows that treatment was significantly improved as the mean value lies above 10.00 mm.

From the single t-test, the mean value for right eye and left eye in 2 weeks were 8.8293 and 8.8731 with the p-value 0.12591×10^{-16} and 1.0092×10^{-22} respectively while the mean value for right eye and left eye in 4 weeks were 16.0127 and 16.5443 with the p-value 1.4066×10^{-20} and 1.2017×10^{-21} respectively.

Hence, the result was significant as in the article Sindhu *et al.*^[14] the result was significantly improved at 2 weeks as compared to day 0.

CONCLUSION

The aim of the study was to evaluate the effect of CMC as lubricating agent on dry eye. The study concluded that DES is treated with artificial tear or tear conservation technique with varying degree of success. The efficiency of CMC was assessed according to measures recorded in the objective tests for assessing the state of the eye surface. The absence of the side effects allows us to conclude that the frequent application of 0.5% isotonic solution of CMC without preservatives on the eye surface is safe and well tolerated. In this study the effects after 2 weeks of treatment in compared to 0 week is found to be improved but not significant. While after 4 weeks of treatment, the effect was significant with the mean higher than 10.00 mm and p-value < 0.05. Thus, the result was found to be significantly effective.

LIMITATIONS

Our study has several limitations including size of the study group along with age limit because patient less than 17 years of age were excluded. Moreover only those patients were selected who are suffering from DES only, thereby further narrowing our study population. The entire patient didn't arrive during the follow up procedure hence 100% analysis of the patient eyes condition after administration of lubricating agent was not carried out. The results of this study might have been affected by the following factors, short duration of study (6 months) which resulted in a small sample size, seasonal variations in disease pattern and drug utilization. Furthermore improvement in eye condition of patients during four weeks of follow up was confirmed only on observation of sign and symptoms.

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