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Effectiveness of Smart Phone App for Self-assessment of Dry Eyes in Smartphone Users

Dr. Hemant Patel*, Dr. Rajul Shah, Dr.R.N. Kothari and
Dr. Mudra Pathak

Abstract--- Purpose: *Smart phone App (Dry Eye Relief) effectiveness for detection of Dry Eyes and self-monitoring of dry eyes in smartphone users.*

Methods: *250 cases with age group of 18-35 years of age having access and comfort for using smart phones underwent Schirmer's test, TBUT, OSDI score test, along with a battery of tests performed using the App to assess the blink rate, blink interval and subjective comfort with details on lifestyle, screen time and contact lens use. We compare manual OSDI with App's OSDI and classify the persons to mild, moderate and severe dry eyes. The clinical test to diagnosed dry eyes are compared with digital tests offered by the smartphone app.*

Results: *Our study has maximum persons in age group of 18-22 years with no sex predisposition. On comparison of our OSDI and App score, both are equal (Pearson's correlation) in diagnosing dry eyes but patient satisfaction rate, ease of understanding and less time consuming was noted in App Score (0.873). We found a negative correlation between TBUT with blink rate (-0.830) but no correlation between blink interval (0.087) to TBUT. Also with Schirmer's test we found a negative correlation with blink rate (-0.853) but no correlation between blink interval (0.082). Though TBUT (0.006) and Schirmer's (0.1) lack of positive correlation with subjective discomfort, interestingly we found that patients with dry eye can stare more at the screen than people with no dry eyes.*

Conclusion: *The smartphone app is effective means for screening of dry eyes by self-assessment and keep track on its progression in techsavy population as they have more vulnerable for dry eye and they are comfortable using such apps. But, still there is need to standardize protocol and criteria for diagnosis of dry eye. It is free, handy, easy to use and automated reporting for user understanding.*

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Keywords--- *Dry Eyes, Smartphone App, Dry Eyes Diagnosis, Self-assessment of Dry Eyes.*

I. INTRODUCTION

Dry eye disease (DED) is characterized by dryness of the conjunctiva and cornea because of decreased function of the tear and rapid evaporation. [(1)] It affects millions of people all over the world affecting their quality of life. [(2)] The Dry Eye Workshop (2007) defined it as a multifactorial disease of the tears and ocular surface that results in symptoms of discomfort, visual disturbance, and tear-film instability, with potential damage to the ocular surface. It

Dr. Hemant Patel, Assistant Professor, Department of Ophthalmology, Sumandeep Vidyapeeth Deemed to be University, Vadodara.*
Dr. Rajul Shah, Second Year Resident, Department of Ophthalmology, Sumandeep Vidyapeeth Deemed to be University, Vadodara.
E-mail: zilro93@gmail.com
Dr.R.N. Kothari, Professor and HOD, Department of Ophthalmology, Sumandeep Vidyapeeth Deemed to be University, Vadodara.
Dr. Mudra Pathak, Second Year Resident, Department of Ophthalmology, Sumandeep Vidyapeeth deemed to be University, Vadodara.

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is accompanied by increased osmolarity of the tear film and inflammation of the ocular surface [3-5]

Patients complain of a constellation of symptoms like a dry gritty feeling in the eyes that is often accompanied by burning, redness, and the sensation of a foreign object in the eye. Early diagnosis of mild dry eye disease can help us for prompt intervention by adapting various methods of lifestyle modification, reducing screen time and the dependency on medications.

Dry eye prevalence in India is 32% in the age group of 21-40 years, compared to global prevalence of 18.4%. [6] The risk of the dry eye disease increases with old age, female gender, collagen vascular disease, antihistamines, postmenopausal estrogen treatment, refractive surgery of cornea [7] affecting the ability to perform certain activities requiring sustained visual attention (e.g. reading, driving), and reduced productivity in the workplace [8]

The Ocular Surface Disease Index (OSDI; Allergan, Inc., Irvine, California, holds the copyright), a PRO questionnaire, was designed to provide rapid assessment of the range of ocular surface symptoms related to chronic dry eye disease, their severity, and their effect on the patient's ability to function. [9] The OSDI includes the following 3 domains: ocular symptoms, vision-related function, and environmental triggers. [10-11]

With the availability of a smart phone App we can motivate people to perform quick tests with the expectation of getting easy DED screening and thus help in increasing the number of diagnosed cases. [12] With the rising number of smart phone users in India, estimated 468 million in 2017 [13] , and the App being user friendly with providing exercises and training can be used by lower socio economic groups, thus increasing the diagnosis rate.

As no definite treatment is available yet, we mainly stress on early detection and prevention by conservative methods like enriching diet with food rich in omega fatty acid, sufficient hydration, practicing 20-20-20 rule [14] to prevent digital eye strain and many more. This study may lead to further understanding of dry eye symptoms and identify at-risk individuals who should be clinically evaluated, potentially improving prevention or early treatment of dry eye disease.

II. MATERIAL AND METHODS

We performed a cross sectional observational study on 250 persons within age group of 18-35 years having access and comfort for using smart phones underwent Schirmer's test, TBUT, OSDI score test, along with a battery of tests performed using the DryEyeRelief App to assess the blink rate, blink interval and subjective comfort with details on lifestyle, screen time and contact lens use. We compare manual OSDI with App's OSDI and classify the persons to mild, moderate and severe dry eyes. The clinical test to diagnosed dry eyes are compared with digital tests offered by the smartphone app in Department of Ophthalmology, Sumandeep Vidyapeeth University, Vadodara, and Gujarat.

Inclusion criteria:

1. Age group 18 – 35 years
2. Smart phone users who are comfortable to use App
3. Availability of smart phone
4. Computer Users

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5. Best corrected visual acuity >6/18

Exclusion criteria:

1. Age less than 18 years and more than 35 years
2. Non Smart phone users
3. Co morbid eye conditions
4. Already on any prior topical medical treatment for dry eyes
5. Topical treatment for any other ocular disease
6. Best corrected visual acuity <6/18

Statistical method applied in study: Pearson's correlation test used to compare results. We used Whatman no. 41 strip of 35 mm for Schirmer's test, after instilling 0.5% paracaine eye drops and wetting of strip was recorded and evaluated after 5 mins.[15] Followed by fluorescein is instilled into the patient's tear film and the patient is asked not to blink while the tear film is observed under a broad beam of cobalt blue illumination and counted for 10 seconds.[15] We gave printed hard copy of the OSDI questionnaire downloaded from the Internet and according to these findings, we divided our patients in 3 groups of mild, moderate and severe dry eyes. After performing these test, we gave half hour to persons for rest and then perform tests on smartphone with DryEyeRelief app (© Optometrist Calgary INC) downloaded free from App Store/Play Store.

III. RESULTS

In our study of 250 persons, we divided them into 3 grade of mild, moderate and severe dry eye according to Schirmer's test, TBUT and symptoms of dry eyes.

Table 1: Classification of Persons According to Dry Eye Classification

	Cases	*Percentage (%)*
Mild	100	40.0
Moderate	130	52.0
Severe	20	8.0
Total	250	100

Table-1 represent the classification, showing 100 cases (40%) of study population in mild grade, 130 cases (52%) in moderate grade and remaining 20 cases (8%) in severe grade. We had no significant sex preponderance in our study as a young population was chosen.

Table 2: Details of Tests Results in various Dry Eye Classes

	Mild DED	*Moderate DED*	*Severe DED*
Age (years)	26.30±4.78	24.0±4.59	19.25±1.5
Classical tests			
Schirmer's II (mm)	12.92±1.38	9.25±1.03	2.5±0.58
TBUT (sec)	12.23±0.72	7.62±1.38	1.25±0.95
OSDI	19.60±3.76	29.0±3.01	53.28±10.0
Application based test			
Blink rate (/min)	12.92±2.13	12.75±3.01	24.5±10.21
Blink interval (sec)	15.61±13.77	10.25±13.24	13.75±12.68
App dry eye score	9.38±1.19	13.62±1.30	19.0±1.41
Subjective comfort (sec)	38.76±30.73	29.25±27.45	39.75±52.80

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Table-2 shows age distribution and various test results in mild, moderate and severe grades. Mild group have average age of 26.30±4.78 years with max age of 35 years and min age of 19 years. This group have mean value of Schirmer's test of 12.92±1.38 mm and TBUT is 12.23±0.72 sec. Mild dry eyes group have mean blink rate of 12.92±2.13/min and blink interval of 15.61±13.77 secs measured by DryEyeRelief app. The mean OSDI score of 19.60±3.76, while App dry eye score is 9.38±1.19 with subjective comfort of 38.76±30.73. In comparison with mild group, moderate dry eye group having average age of 24.0±4.59 years with max age of 32 years and min age of 19 years, with mean Schirmer's value of 9.25±1.03 mm and TBUT 7.62±1.38 sec, with OSDI score of 53.28±10.0. This group has mean blink rate of 12.75±3.01/min and blink interval of 10.25±13.24secs and App dry eye score of 13.62±1.30 with subjective comfort of 29.25±27.45 measured by DryEyeRelief app. Severe group have average age of 19.25±1.5 years with max age of 21 years and min age of 18 years, with mean Schirmer's test value of 2.5±0.58 mm and TBUT 1.25±0.95 sec with OSDI score of 53.28±10.0. Severe dry eyes group have mean blink rate of 24.5±10.21/min and blink interval of 13.75±12.68 secs, App dry eye score is 19.0±1.41with subjective comfort of 39.75±52.80 measured by DryEyeRelief app.

On comparing Schirmer's test to blink rate and blink interval by Pearson correlation, we have found significant negative correlation between Schirmer's test and blink rate (-0.853), but there is no statistical significance found between Schirmer's test and blink interval (0.082). We also compared Schirmer's value with subjective index of app and found that there was no statistical significance between them (0.1).

On comparing TBUT test to blink rate and blink interval by Pearson correlation, we have found significant negative correlation between TBUT test and blink rate (-0.830), but there is no statistical significance found between TBUT test and blink interval (0.087). We also compared TBUT value with subjective index of app and found that there was no statistical significance between them (0.006).

On comparing OSDI with App score by Pearson Test, we found a positive correlation between them of 0.873 and a significant p value of <0.0001.

Table 3: Classification of Persons on Basis of Lifestyle and Screen

	Lifestyle	*Percentage (%)*
Mobile usage (>4 hours)	132	52.8
Computer usage (>4 hours)	70	28
Reading (>4 hours)	20	8
Regular (<4 hours)	28	11.2
Total	250	100

Patients were classified based on their lifestyle and screen time with max users of mobile being 132 (52.8%) and computer 70 (28%). People with long reading hours >4 are 20 (8%) and <4 are 28 (11.2%) respectively.

IV. DISCUSSION

In our study, we found mean age of 26.30 years, 24 years and 19.25 years in mild, moderate and severe age group respectively suggesting more prevalence in younger population which is similar to a study by Whitney Hauser showed that 76% of dry eye symptom were among 18 – 34 years old due to multiscreen lifestyles. [(16)]. PR Newshire suggested that alarming rise of DED is due to spending more hours in front of the screen (75%) and lack of physical

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and outdoor activities. [17]While a study by Shanti Y, Shehada R[18] they found that prevalence of dry eyes was maximum in the age of 45 years and was due to age related factors and more common in females while our study showed equal preponderance in both sexes, due to section of younger group and elimination of hormonal factors.

According to lifestyle we found that mobile and computer users (>4 hours) had more chances of development of dry eyes at a young age. [16,17]. Dry eyes has a negative impact on quality of life as well affecting the daily chores like reading and driving ability and associated with increased anxiety, stress and depression as observed by Nina Noor et al.[19]

In our study we found a positive correlation between OSDI and App Dry Eye score suggesting both are reliable for classifying dry eyes, while a negative correlation between blink rate, blink interval and Schirmer's test, TBUT and blink rate and blink interval. TBUT and Schirmer's did not show any correlation with subjective comfort either.

As per Miller KL [20], their study suggested that based on OSDI score patients can be categorized as having a normal ocular surface (0-12 points) or as having mild (13-22 points), moderate (23-32 points), or severe (33-100 points) ocular surface disease which is similar to our study with 13-23 points in mild, 24-32 points in moderate and 33 and above points in severe category. According to our App dry score 8-11 points in mild, 12- 15 points in moderate and 16-20 points in severe category. But we found App dry score more user friendly, less time consuming and provided similar interpretation compared to OSDI.

Other app used is DryEyeRhythm App in a study by Inomata T [21] suggested that App identified individuals with diagnosed and undiagnosed symptomatic dry eye and the associated risk factors which could play a role in earlier prevention or more effective interventions for dry eye disease. We could not find any study using the similar app to compare our results. We do not have a standard protocol and app available for dry eye detection based on smartphone technology yet but they can surely aid in assessment and follow-up and later on as standardized protocols develops, it also help in diagnosis.

V. CONCLUSION

The smartphone app is effective means for screening of dry eyes by self-assessment and keep track on its progression in techsavy population as they have more vulnerable for dry eye and they are comfortable using such apps. But, still there is need to standardize protocol and criteria for diagnosis of dry eye. It is free, handy, easy to use and automated reporting for user understanding.

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