Original Article

Relationship between Smartphone Use and Dry Eye Symptoms in Children

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Abstract

Purpose: *To study the relationship between smartphone use and dry eye disease (DED) in pediatric age group.*

Materials & methods: *A prospective, quasi-experimental study of 78 children diagnosed with DED (as per International Dry Eye Workshop guidelines) was conducted at a tertiary care hospital, Odisha over the duration of 9 months from July 2016 - March 2017. Questions on time of smartphone/other visual display terminal use, continuous reading hour, outdoor activity were asked to older children and parents of younger children. Symptoms were noted and the Ocular Surface Disease Index (OSDI) score calculated. Ocular examination including slit lamp, inter blink interval (IBI), tear-film breakup time (TBUT) & Schirmer's test (ST) done. The patients were divided into Category A (continuous smartphone use for >/=1hr) & Category B (use for <1hr at a stretch/intermittent use).*

Results: *Of the 78 children (43.6% rural & 56.4% urban) 88.4% belonged to Category A and 11.6% to Category B. Mean IBI in Category A was 2.89s & in Category B it was 4.32s, mean TBUT was measured at 8.87 s and 9s in both the categories respectively, and a Schirmer's value of <10mm without anaesthesia in both the categories. Patients were reviewed again after discontinuing use of smartphone for 1 month. Improvement in symptoms and dry eye scores noted with the values being statistically significant (p<0.05).*

Conclusion: *Smartphone use continuously for longer time can lead to symptoms of DED in children. With increasing smartphone use among younger population this is a cause of concern.*

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Keywords: *Smartphone, dry eye, Schirmer's test.*

Introduction

Dry eye disease (DED) is one of the most commonly encountered ocular morbidities in an ophthalmology clinic. About 25% of patients who come for eye check-up report with dry eye symptoms, making it a growing public health concern and one of the most common conditions seen by ophthalmologists.[1] Although, dry eye disease has usually been considered a disease of the elderly and the post-menopausal women, of late there has been a rise in patients presenting with dry eye symptoms in the paediatric age group.[2,3,4,5] Though, usually this condition in children is either overlooked or attributed to other causes of ocular irritation (allergies), recent studies have claimed an association of paediatric dry eye disease with the usage of video display terminal units.[6,7]

Surveys conducted earlier have shown that there will be 15.6% smartphone users and annual rate of growth of smartphone users in India would be around 129%, even more than that of China (109%).[8] The concern grows as the average age of a child getting a smartphone is 10.3 years.[9] Use of these smartphones and/or other video display terminals (laptops, desktops, tablets, television) for long hours has been associated with a decreased maximum blink interval, hence development of dry eye symptoms.[10,11] In addition, many people report ocular fatigue after prolonged work with video display terminals.[12]

Paediatric DED is a growing concern for ophthalmologists all over, and its importance should not be undermined. Therefore this study was conducted as an attempt to establish any validity in the development of DED due to smartphone usage. The objective is to study relationship between smartphone usage and the development of dry eye disease in the paediatric age group.

Materials and Methods

It was a prospective, quasi-experimental study including 78 diagnosed patients of dry eye disease in the age group of 5-15 years, attending out-patient department (OPD) of a tertiary care eye hospital in Cuttack, Odisha during July 2016 to March 2017. The study was done with the approval of the institutional ethics committee. During the study period, a total of 735 patients, in the age group 5-15 years, attending out-patient department (OPD) with the chief complaints of redness, itching, watering, and foreign body sensation were examined. A thorough history was taken, the signs and symptoms were evaluated and the patients were subjected to questionnaires. Questionnaires were designed to obtain information regarding mean daily duration of video display terminal (smartphone, tablets, computer, television, and laptop) use, learning (reading and writing), outdoor activities, and past history of allergic disease and anti-histamine drug use.

The symptoms were evaluated on the basis of the Ocular Surface Disease Index (OSDI) score, where patients were asked a series of 12 questions, according to the answers the score was obtained on a scale of 0-100. The patients were evaluated at presentation for fluorescein corneal staining, tear film break-up time (TBUT), Schirmer's test (ST), and inter-blink interval (IBI). Dry eye disease was diagnosed in patients with TBUT of less than 10 seconds, Schirmer's test value of less than 15mm, positive corneal and conjunctival staining,(any two of the above) and modified OSDI score more than 20. Inter-blink interval was measured by averaging the number of total number of blinks observed for half-an-hour. Patients were advised to avoid smartphone use for 1 month. After cessation, the parameters were evaluated and compared again at the end of 1 month. No additional therapy (lubricants or anti-allergic medications) was provided to them during the period. All parameters were measured by a single observer.

Refractive error, if any, was also recorded as per questionnaire. Those with uncorrected errors were provided with glasses before including them into study group.

For ease of comparison and to better elicit the relationship between dry eye disease and smartphone use, the patients were divided into two categories: Category A, for those using smartphone continuously for more than or equal to 1 hour, continuously, at any given time, and Category B, for those using it for less than 1 hour continuously, at any given point of time. The inclusion and exclusion of patients into this study were decided as per the following criteria.

Inclusion criterion

- Patients diagnosed with DED between 5-15 years of age.

Exclusion criteria

- Children who underwent any type of eye surgery in the past six months.
- Children who had nocturnal lagophthalmos.
- Children who had eyelid problems like trachoma, trichiasis, distichiasis or epiblepharon.
- Children who had allergic conjunctivitis with the use of antihistaminic drugs.
- Contact lens wearers.
- Children who had any congenital, endocrine or auto-immune disease.

Figure 1 shows the flowchart of the methodology used in a concise manner.

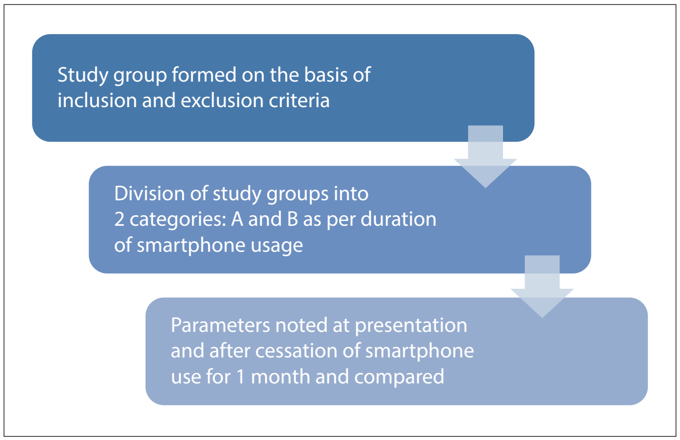

Figure 1: *Flowchart of study methodology*

Statistical Methods

Clinical information, including complete ophthalmic examination along with demographic details, was entered into the spreadsheets in Microsoft Excel. The statistical analysis employed SPSS software, version 16.0 (SPSS Inc., Chicago, Illinois, USA). Student's t-test was used to compare means among groups. A p value of less than 0.05 was considered significant.

Results

Of the 78 patients, 69 cases belonged to category-A whereas 9 cases belonged to category-B, as shown in Figure 2. The mean age of patients in category-A was 11.5 ± 1.6 years and that of patients in category B was 13.5 ± 0.8 years.

Figure 3 shows the sex distribution of patients in both the categories. In category-A, 78.3% were male and 21.7%were female. In category-B, 77.8% were male and 22.2% were female. Patients from urban area were 44 in number (56.4%), of which 43 cases belonged to category-A and from rural area were 34 in number (43.4%), of which 26 cases belong to category-B.

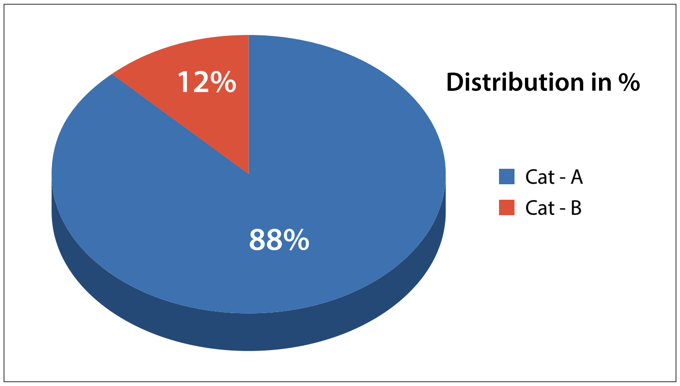

Figure 2: *Distribution of DED patients into two categories: A and B, Legend: Cat-A: Category-A; Cat-B: Category-B*

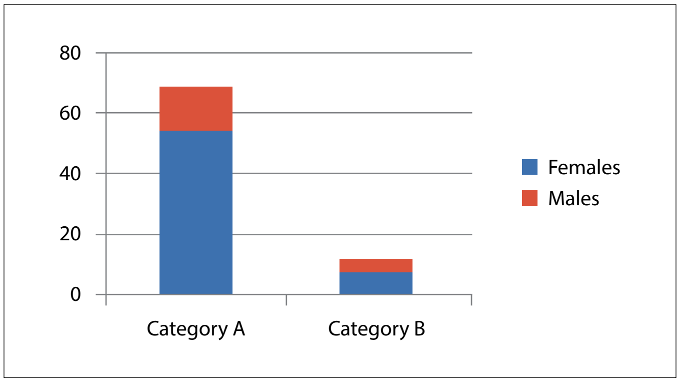

Figure 3: *Sex distribution of paediatric DED patients in both the categories*

15 children (19.2%) were found to suffer from refractive errors. The distribution is shown in Figure 4. 54% were found to be myopic with a spherical equivalent: -2.21±1.45D. All cases belonged to category-A.

It was observed, as shown in Figure 5, that the average duration of time spent during outdoor activities was greater in Category B, with a mean 2.10 hours as compared to a mean of 1.32 hours by the children in Category A, while the time spent on smartphones and other visual display terminal use was higher (mean of 5.33 hours) in Category-A as compared to that of Category-B (mean of 3.28 hours). It was statistically significant with p<0.001 by independent t-test.

The parameters of study noted before and after cessation of smartphone use in both the categories also showed remarkable change, as shown in Table 1 and Table 2. Mean TBUT was recorded at 8.87±0.55s in category-A that later improved to 10.26±0.34s, with an improvement in 92.1% of subjects (p<0.0001). Those in category-B recorded a higher mean TBUT at 9.0±0.7s at baseline, which further improved to 10.89±0.93s on cessation (p=0.002). Mean IBI at baseline for category-A was recorded at 2.89±0.08s which improved to 4.31±0.19s, (p<0.0001). Mean IBI was recorded at 4.32±0.19s at baseline in category-B; later improved to 5.34±0.32s (p<0.0001).

Similarly values in ST also showed improvements in both categories. It improved from 8.7±0.8 to 13.3±0.9 in Category-A (p<0.0001) and from 9.5±0.7 to 14.8±0.8 in Category-B (p<0.0001). Fluorescein staining was reported in Category-A mostly, 78.26% of which showed no staining after cessation of smart phone use for a month.

Table 3 shows that the OSDI scores also showed significant results in favour of smartphone cessation. There was 54.7% decrease in mean OSDI score in category-A (p<0.001) and 60.2% decrease in mean OSDI score in category-B (p<0.004). Statistical significance calculated by independent t-test.

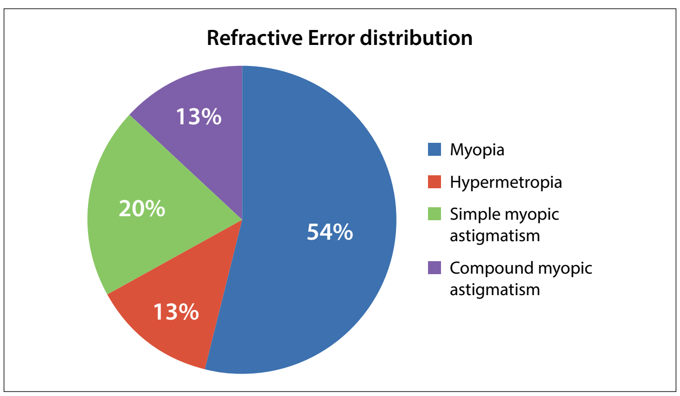

Figure 4: *Distribution of type of refractive error in DED patients diagnosed with refractive errors*

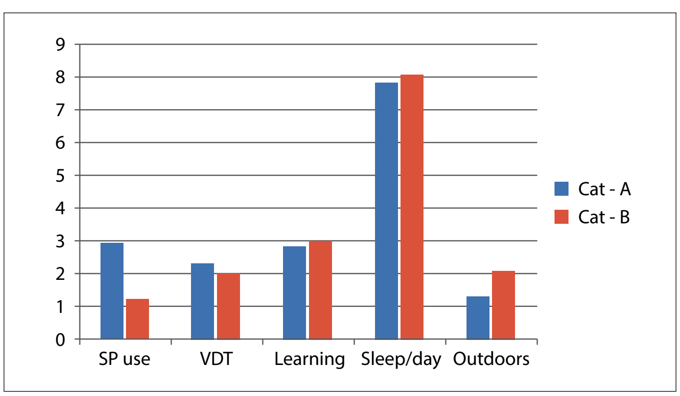

Figure 5: *Average duration of time spent in hours on various activities in both the categories, Legend: Cat-A: Category-A; Cat-B: Category-B*

Table 1: Comparison of results after cessation of smartphone use in parameters examined in category-A

		Before cessation	After cessation	% showing improve-ment	% showing no change	% showing worsening
Males	Mean TBUT	8.15	10.23	92.6	7.4	-
	Mean IBI	2.88	4.28	92.6	7.4	-
	Mean Schirmer's Test value	8.65	13.44	92.6	7.4	-
	No of Fluorescein positive cases	20	4	80	20	-
Females	Mean TBUT	8.17	10.07	93.3	6.7	-
	Mean IBI	2.89	4.35	93.3	6.7	-
	Mean Schirmer's Test value	8.97	13.13	93.3	6.7	-
	No of Fluorescein positive cases	3	1	66.67	33.33	-

TBUT: Tear film break-up time, IBI: Inter-blink interval

Table 2: Comparison of results after cessation of smartphone use in parameters examined in category-B

		Before cessation	After cessation	% showing improve-ment	% showing no change	% showing worsening
Males	Mean TBUT	9.14	10.71	71.42%	14.28%	-
	Mean IBI	4.37	5.11	71.42%	14.28%	-
	Mean Schirmer's Test value	9.57	14.86	71.42%	14.28%	-
	No of Fluorescein positive cases	none	none	-	-	-
Females	Mean TBUT	8.5	11.5	100%	-	-
	Mean IBI	4.15	5.15	100%	-	-
	Mean Schirmer's Test value	9.5	14.5	100%	-	-
	No of Fluorescein positive cases	none	none	-	-	-

TBUT: Tear film break-up time, IBI: Inter-blink interval

Table 3: Change in mean OSDI scores in both the categories

	Category-A	Category-B
Before	36.76	31.45
After	16.63	12.53
% change	54.7%	60.2%

OSDI: Ocular Surface Disease Index

Discussion

Many studies have earlier been carried out to establish the clinical condition of computer vision syndrome as well as the ocular fatigue associated with the use of visual display terminals. However, the connection between the usage of smartphones and the development of dry eyes was first established in the landmark study by Moon et al. They had established a total of 6.6% with dry eye disease, while our study showed a larger number with 10.6%.[10]

In their study, Moon et al had found that 86.7% of those developing dry eyes belonged to urban areas, whereas only

13.3% belonged to rural areas (p=0.03).[10] Our study differed with 56.4% belonging to urban areas and 43.6% belonging to rural areas with no statistical significance. Females comprised of 53.4% of the affected as compared to 21.8% in our study.[10]

Prevalence of spectacle use was also found to be higher in those with DED, across various sub-groups, in the study by Moon et al. Spherical equivalent varied from −2.13±2.34D to −1.77±2.12D. In our study too, maximum cases with refractive error were found to be myopic (Spherical equivalent: -2.21±1.45D).[10] Prevalence of dry eye was also found to be more in myopic children in the study by Fahmy et al.[16]

Moon et al observed that an average of 5.46 hours was spent on smartphone and VDTs and a meagre 1.47 hours on outdoor activities in the affected group. Similar values were noted in the Category-A of the affected group in our study with an average of 5.33 hours spent on smartphones and VDTs and 1.32 hours spent outdoors.[10] The values in both studies were statistically significant, with the study by Moon et al showing significance for both smartphone usage and VDTs separately (p=0.027 and 0.001, respectively), even though they could not establish a relation between risk of dry eye disease and daily television and computer use.[10] They observed that increased outdoor activity time reduced the rate of pediatric DED (OR = 0.33).[10]

In their study of effect of cellular videogames played on smartphone on dry eye symptoms by Park et al, a difference of frequency of blinking, dry eye symptom scores and amount of tears was noted (p<0.001), with the measurements conducted 61 minutes after continued smartphone use.[13] This probably gives an insight as to why the major proportion of children diagnosed with DED fell under category-A.[13]

Following cessation of smartphone use, Moon et al observed that a significant reduction in the number of DED patients with punctate epithelial erosions (PEEs) (p<0.001) and TBUT (p<0.001) which reduced from 10.00±3.25 s to 11.33±2.29s on cessation of smartphone. Similarly in our study, the mean TBUT had increased, in both categories, following cessation of smartphone use.[10]

Change in OSDI scores following cessation of smartphone use was clinically significant in our studies (Cat –A: p<0.001; Cat – B: p=0.004). It was also found to be clinically significant (p<0.001) and had reduced from 30.74±13.36 to 14.53±2.23 in the study by Moon JH et al.10 The mean inter-blink interval also improved from 2.89 to 4.58s in category-A and from 4.32s at baseline to 5.34s in category-B, following smartphone cessation with the improvement of dry eye symptoms. They were comparable with the previous studies by Tsubota et al, who had recorded a mean IBI of 4.0s and 1.5s for normal and dry eye respectively and Johnston et al, with values of 5.97s for normal versus 2.56 s for dry eyes.[14,15]

Despite the best of our abilities, our study had its own limitations. Since DED has been known to co-exist with allergic conjunctivitis, there are likely chances of overestimation of the diseased group.[6] Moreover, the study had been conducted in a tertiary care hospital of coastal Odisha wherein the effect of relative humidity weighs higher as compared to places that experience dry heat. Confounding factors like socio-economic status and relative humidity were not taken into account.

Conclusion

Increased use of smartphones is a serious issue that can result in ocular surface symptoms, especially in paediatric age group. Continuous use is found to be more detrimental than intermittent use or judicious use with enough breaks to avoid ocular fatigue. Therefore, close observation and caution should be practiced when allowing children to use smartphones.

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