Original article

Xerosis meter-an electro-physiological device for quick screening of dry eyes

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Abstract

Aim: To study the role of 'Xerosis Meter' in screening of dry eye cases in a large population and compare its results with Schirmer's test and tear break-up time.

Materials and method: In a cross sectional study with a control group dry eye was evaluated with Xerosis Meter, Schirmer test and tear film break-up time (TBUT). Cases included in the study were divided into two groups. Group I (Control Group) comprised of asymptomatic patients while Group II (Test Group) had patients showing symptoms and signs of dry eye. The Group II was further divided into two subgroups. Group IIa had cases showing positive result with either of the two tests Schirmer test or TBUT. Group IIb had cases which showed positive results with Xerosis Meter but normal results with the other two tests.

Statistics: All the observations were statistically analyzed using SPSS version 11.5 software. The results obtained were compared statistically using unpaired t-test and chi-square test. The p value of < 0.05 was considered as significant.

Results: There was a statistically significant difference between the means of Xerosis Meter, Schirmer test and TBUT of the two groups: Group I and Group IIa (p value < 0.001). On comparing Group I and Group IIb the difference was found to be statistically significant with Xerosis Meter (p value < 0.001). The sensitivity and specificity of Xerosis Meter were 85.7% and 80.2% respectively. This was higher than that of the Schirmer's test (81.3% and 74.9%) and TBUT (73.2% and 68.7%).

Conclusion: The "Xerosis Meter" is an effective alternate in screening of dry eye cases. It is more effective than the TBUT and as effective as the Schirmer's test in detecting both the normal and dry eye patients.

Introduction

Dry eye is a disturbance of Lacrimal Functional Unit (LFU) which works as an integrated system. It comprises of lacrimal glands, ocular surface (cornea, conjunctiva and meibomian glands) and lids along with sensory and aqueous-motor nerves which connect them (Stern et all, 1998). This functional unit controls the secretion of the three major components of tear film in a regulated fashion. Any disturbance in this system leads to ocular surface changes, hampering tear film stability.

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Tear film alteration either in terms of its composition, osmolarity or its decreased secretion leads to ocular surface inflammation. This is accompanied by ocular discomfort, visual disturbance, burning or foreign body sensation (Gilberd J, 2000). Dry eye though an innocuous disorder to present with, can be very debilitating to the persons suffering from it, although it may be asymptomatic in some individuals. Diagnosis of dry eye by symptoms alone is sometimes difficult because various other surface disorders share similar symptoms. Moreover, the dry eye patients may present with various complaints that correlate poorly with objective signs of the disease (Pavia et all, 1994). Persistence of these changes over a period of time can cause structural changes in the conjunctiva and cornea by activating genes responsible for the

differentiation (Nakamura et al, 2001). Thus diagnosing dry eye early in the course of the disease is beneficial to the patient.

Various tests have been developed to diagnose dry eye but none of them are reliable objective tests. Some of them are time consuming, difficult to perform or require an expensive setup. Some are not sensitive enough to detect eyes which are at potential risk of developing dry eye. Two most routinely used tests, the Schirmer test and the TBUT, too have their own shortcomings.

Xerosis Meter is a new, reliable, easy to use and less time consuming instrument which has been developed and studied (Gupta et al, 2006). It can overcome the above mentioned shortcomings. Thus it can be effectively used as a screening tool for dry eye. This instrument can be a breakthrough for the early and reliable diagnosis of dry eye.

Materials and methods

A comparative cross sectional study was conducted at a tertiary care hospital from October 2007 to September 2008. A total number of 315 patients (630 eyes) were enrolled in this study, which were further divided into 2 groups (Table 1).

Table 1
Distribution of Cases in Different Groups

Group	Cases	Males	Females
I	235(74.6%)	121(38.4%)	114(36.2%)
IIa	56(17.8%)	27(8.6%)	29(9.2%)
IIb	24(7.6%)	9(2.8%)	15(4.8%)
TOTAL	315(100%)	157(49.8%)	158(50.2%)

Group I (Control Group) consisted of 470 eyes of 235 patients, who did not have any symptoms or signs of dry eye. Group II (test group) comprised of 160 eyes of 80 patients, who were having symptoms and signs of dry eye. These were further divided into two subgroups: Group IIa and Group IIb.

Group IIa consisted of 112 eyes of 56 patients, who were positive to either Schirmer test or Tear Film Break Up Time (TBUT). Group IIb comprised of 48 eyes of 24 patients which showed positive Xerosis Meter reading but negative results for both the above mentioned tests.

After obtaining an informed consent, subjects underwent a thorough clinical evaluation for dry eye syndrome, including a detailed history and a comprehensive ophthalmological examination. The results of Xerosis Meter were compared with those of Schirmer's test and TBUT. All three tests were performed on all the patients included in the study after duly explaining the procedure and taking an informed consent. The tests were performed by the same individual and under the same settings.

Xerosis Meter is a sensitive analog galvanometer (Fig. 1), the property of which has been exploited to be used in diagnosing dry eye. It can measure resistance in a range of 0 - 20 Mega ohms.

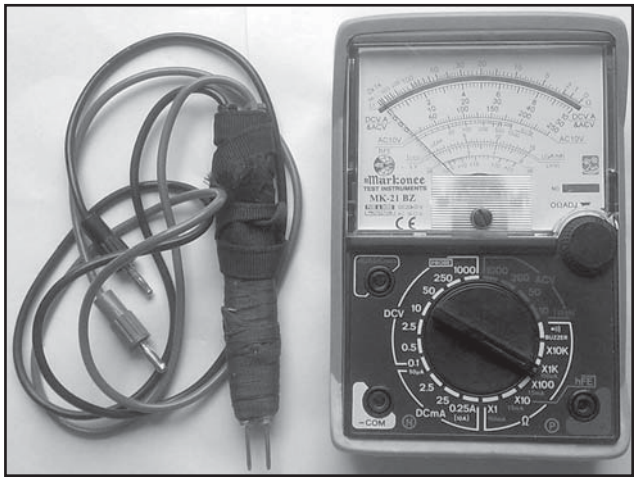

Fig 1: Xerosis Meter , a sensitive analog galvanometer.

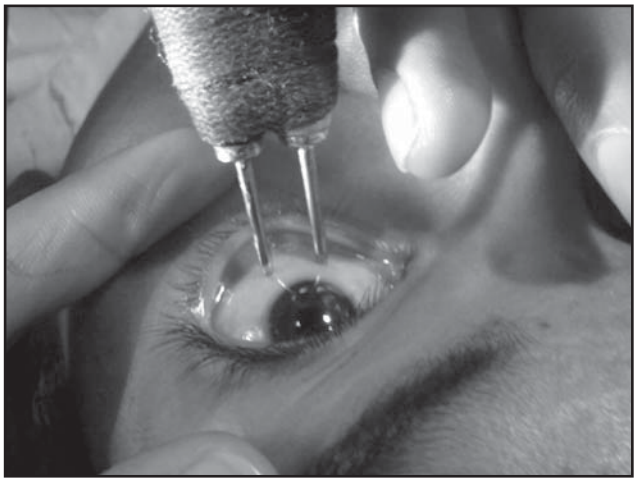

Fig 2:
Measurement of conjunctival resistance by Xerosis Meter.

Basic principle of this instrument is that the conductivity of any tissue is directly proportional to its wetness (Gilbard J, 1994). The drier the tissue more is the amount of resistance offered to the flow of current. Thus in our study, amount of resistance measured varied directly with the severity of dryness of the conjunctiva; more dry it was, more was the measured resistance. Conjunctival resistance was measured in Kilo ohms (K-ohm) using Xerosis Meter without anesthesia (Fig. 2).

The space between the two test leads was fixed at 7 millimeter (mm), by attaching the two plastic handles of the leads together. The leads were kept vertically on the conjunctiva taking care that no pressure was applied. The resistance of inferior, superior, and temporal parts of bulbar conjunctiva was recorded as the amount of deflection of the pointer. The overall mean value of these three readings was taken for each eye.

Schirmer test and TBUT was also performed, without anesthetizing the conjunctiva.

Diagnostic criteria to label the eye as dry eye were taken as:

a) positive for symptoms and signs of dry eye and
b) Positive to either of the two tests, viz. Schirmer test and TBUT.

Criteria for the two tests being positive were taken as:

a) Schirmer test d" 5millimeter after 5 minutes (Norn, 1974)
b) TBUT d" 10seconds (Lemp, 1973).

Statistical analysis

All the observations were statistically analyzed using SPSS version 11.5 software, Inc, Chicago, Illinois, USA. The significance between control and test groups was calculated using unpaired t-test. To compare the two tests within control group and within test group, the chi-square (X^2) test was used. A p-value of < 0.05 was considered significant. Sensitivity and specificity of each test were also calculated.

Results

Our study included almost equal number of males and females. Out of 315 patients, 157 (49.8%) were males and 158 (50.2%) were females.

The mean reading of Xerosis Meter in Group I was 31.8 ± 3.1 Kohm (28.7-34.9 Kohm). In males it was 31.9 ± 3.1 Kohm and in females 31.9 ± 2.9 Kohm. A reading of 35Kohm (mean + 1 Standard Deviation, S.D.) was taken as upper limit of normal. In Group IIa mean reading of Xerosis Meter was found to be 38.5 ± 3.8 Kohm (34.7-42.4 Kohm). In this group, males had a reading of 38.2 ± 4.1 Kohm and females of 38.9 ± 3.4 Kohm. The mean reading of Xerosis Meter in Group IIb patients was 38.4 ± 1.5 Kohm (36.9-39.9 Kohm).(Table 2)

Table 2
Mean of Xerosis Meter (in Kohm), Schirmer test (in mm), TBUT (in sec)

Groups	Xerosis Meter	Schirmer Test	TBUT
I	31.8 ± 3.1	21.3 ± 12.6	18.4 ± 7.5
IIa	38.5 ± 3.8	4.8 ± 4.2	7.9 ± 3.8
IIb	38.4 ± 1.5	22.6 ± 7.6	19.3 ± 5.7

No statistically significant difference was found between males and females of all the groups. A statistically significant difference was present between the means of Xerosis Meter of Group I and Group IIa ($p < 0.001$) and Group I and Group IIb ($p < 0.001$), when these were compared with unpaired t-test. (Table 3)

Table 3
Showing Statistical Calculation (p-value)

	Group I and Group IIa	Group I and Group IIb	Group IIa and Group IIb
Xerosis Meter	<.001	<.001	>.05
Schirmer	<.001	>.05	<.001
TBUT	<.001	>.05	<.001

The mean of Schirmer test in Group I, IIa and IIb was 21.3 ± 12.6 mm, 4.8 ± 4.2 mm and 22.6 ± 7.6 mm respectively. The mean of TBUT in these three groups were 18.0 ± 7.3 sec, 7.9 ± 3.8 sec and 19.3 ± 5.7 sec respectively. (Table 2).

A statistically significant difference was present ($p < 0.001$) between the means of Schirmer test and between the means of TBUT of Group I and Group IIa but this was non significant ($p > 0$ .05) in Group I and Group IIb. (Table 3).

Table 4
Xerosis Meter reading in '0' Schirmer test reading

S no	Schirmer test (mm)	Xerosis meter (Kohm)
1	0	39
2	0	48
3	0	45
4	0	42.2
5	0	41.9
6	0	36
7	0	38
8	0	37
9	0	40
10	0	39.3
11	0	39
12	0	44

The sensitivity (85.7%) and the specificity (80.2%) of Xerosis Meter were much higher than the sensitivity and specificity of other two tests (Schirmer test: 81.3%, 74.9% respectively; TBUT: 73.2%, 68.7% respectively).

Chi-square test was applied to compare Xerosis Meter with Schirmer test and TBUT. Xerosis Meter was found to be better than TBUT ($p< 0.01$ in Group I and, $p < 0.05$ in Group IIa) in detecting the normal patients as well as the dry eye patients. The difference was not significant for Xerosis Meter and Schirmer test ($p > 0.05$).

Discussion

A battery of tests has been designed to diagnose dry eye and to grade its severity. But till date, there is not a single gold standard test for this (Lemp, 2007). Dry eye is a debilitating disease, for which early diagnosis and treatment is imperative to lead a normal life. Xerosis Meter had been shown to have promising results in this regard.

We did this study to know the effectiveness of Xerosis Meter as compared to Schirmer test and TBUT. The study was done without using any local anesthetic in any of the three tests as anesthesia leads to decrease in the mean value of Schirmer test (Lambert et al, 1979) and TBUT (Lemp and Hamill, 1973).

Gupta Y et al were first to report the use of the Xerosis Meter in 2006. They standardized the instrument and reported the mean conjunctival resistance + SD of 32.5 +9.9 Kohm in normal eyes. The resistance was found to be 45.47+ 8.8 Kohm in patients with dry eye and took 40 Kohm as a cut off between the normal and dry eyes. They suggested the use of Xerosis Meter as an effective alternative to the presently used tests in diagnosing dry eye.

Our study confirmed the results of the above mentioned study, but was more exhaustive and it also suggested that the Xerosis Meter could be used to differentiate eyes with established dry eye into varying grades of severity, which was not hitherto possible with conventional tests. The conjunctival resistance of both groups IIa and IIb was significantly higher than the mean of group I, showing the increase in resistance of the conjunctiva with the increasing dryness of the tissue. So in patients of dry eye Xerosis Meter showed a positive reading i.e. higher value of the resistance. Thus it was seen that the Xerosis Meter can detect dryness of the conjunctiva.

The cut-off of 35Kohm of Xerosis Meter for dry eye (mean ± 1SD was 31.8 ± 4.1 Kohm, giving mean + 1 SD approximating to 35Kohm) was calculated in our study. The sensitivity of Xerosis Meter thus calculated was 85.7% and specificity 80.2%, which was comparable to that reported by Gupta et al (86.11% and 80.7% respectively) [5].

The normal amount of wetting of Schirmer tears strip is 10-30mm after 5minutes (Doughman et al, 1987) quoted different cut-off values of Schirmer test for dry eye viz. Sjogren 5mm (Norn, 1974), 5.5mm (Van Bijesterveld, 1969), and Schirmer 15mm (Schirmers et al, 1903). Bijsterveld found sensitivity and specificity of Schirmer tests to be 83% and 85% respectively (Van Bijesterveld, 1969). Hansen et al (1983) observed 13% false positives at cut-off value of 5.5mm. In our study the mean reading of Schirmer test observed in control group was 21.3 ± 12.6 mm after 5minutes and in group IIa was 4.8 ± 4.2mm after 5minutes. By taking the criteria of <5mm after 5 min as a cut-off value, the sensitivity and specificity was found to be 81.2% and 74.9% respectively.

The normal range of TBUT is 15-34 seconds (Doughman ey al, 1987). A value less than 10 seconds is considered as abnormal (Lemp M.A., Hamill JR). More recently, based upon the report of (Abelson et al 2002), the diagnostic cut-off falls to < 5seconds when small volumes of fluorescein are instilled in the conduct of the test e.g. using 5 µL of 2.0% fluorescein. If this becomes established then this will decrease the sensitivity of TBUT further. In our study the mean value of TBUT in control group was 18.4± 7.5sec, corresponding to the normal range. The mean value in dry eye patients of group IIa was 7.9 ± 3.8sec and the cut-off value is taken as 10 seconds.

The sensitivity and specificity of TBUT reported by Vitale et al. (1994) were 72% and 61% respectively. These were found to be 73.2% and 68.7% respectively in our study. These, like Schirmer test, were much less than that of the Xerosis Meter (85.7% & 80.2% respectively).

Xerosis Meter was thus much more specific and sensitive than the two most commonly used tests i.e. Schirmer test and TBUT. Moreover, Xerosis Meter was better than TBUT in detecting the normal patients as well as the dry eye patients as confirmed statistically using chi-square test. However, no statistical significance was seen on comparing Xerosis Meter and Schirmer test. Vanley et al (1977) reported TBUT as a poorly reproducible test. Patel et al., 1987, Cho and Yap, 1993, criticized the Schirmer test for being poorly reproducible, time consuming, irritating and having poor diagnostic value especially when attempting to investigate the marginal dry eye. Therefore the Xerosis Meter, if not better, is equivalent to the Schirmer test in detecting the normal and dry eye patients.

Our study also showed the early detection of dry eye cases with Xerosis Meter. These were the cases which were symptomatic for dry eye and were positive with Xerosis Meter. The Schirmer test and TBUT however failed to recognize these early cases of dry eye. (Group IIb) Follow up of such cases can give an important clue in early diagnosis and management of such cases which was not taken up in the present study. In Group II there were some cases which showed '0' reading of Schirmer test but had different readings with Xerosis Meter. The readings with Xerosis Meter ranged from 36 Kohm to 48Kohm.(Table 4) These can thus be further graded into various levels of severity with the help of Xerosis Meter. A proper grading system can be made; and for this a study can be undertaken with large numbers of subjects. Our study has only 12 of such cases and thus could not be used for defining a grading system.

Another important observation which was made in the study was that of the time consumed in performing these test. Xerosis Meter had the advantage of its speed, being fastest among the three tests. Maximum time and cooperation of the patients was required for the TBUT.

Conclusion

The Xerosis Meter is able to effectively detect those cases with established dry eye and those which are in the early stages of development of dry eye. It is a cheap, reliable, quick and effective alternative to the conventional tests. This device can be used easily and requires only minimal cooperation from the patient.

The Xerosis Meter can also be used for monitoring the progress of dry eye and the response to treatment. To further know its effectiveness for the same, a proper and long term follow up is required. The study also highlighted the potential of Xerosis Meter in grading the severity of dry eye but a study on a larger scale is required to develop a proper classification.

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