Modified Schirmer's Test in Normal Eyes: Open versus Closed Eyes and 1-minute versus 5-minute Tests

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Abstract

Purpose: To assess the results of 1-minute and 5-minute Schirmer's test (ST) when the eyes are open (STo) and closed (STc) in normal participants.

Methods: In a comparative, observational case series study, 34 normal volunteers were included in the study. Inclusion criteria were normal ophthalmologic findings except for refractive errors, no use of contact lenses, no history of previous medical or ophthalmic problems, and no current use of medications. STo and STc in 1 and 5 minutes time were performed separately for all subjects with an interval of at least 24 hours using Whatman No. 41 (5x60 mm) with bended end of the paper inserted into the lateral side of the lower conjunctival fornix.

Results: There were 19 females and 15 males with a mean age of 20.8 years (range: 18-23). Mean value of STc was significantly less than STo in both 1 minute and 5 minute tests. One-minute STo and STc showed a significantly less wetting than 5-minute test. Normal distribution was observed for all values. A significant correlation were found between 1-minute and 5-minute tests in both STo and STc; therefore, two equations were proposed to calculate the 5-minute from 1-minute ST. Statistical analysis did not provide a reliable equation for calculating the standard ST (5-minute STo) from the most comfortable state (1-minute STc).

Conclusion: Faster and more comfortable ST (1-minute) is a reliable test to calculate the 5-minute ST in both open and closed eye, using the provided equations. The 1-minute STc is not a reliable test to calculate the 5-minute STo.

Keywords: Closed Eye Schirmer's Test, Open Eye Schirmer's Test, One Minute Schirmer's Test


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**Introduction**

Dry eye is a common condition that is seen with increased prevalence in patients with autoimmune diseases, postmenopausal women, and the elderly. Measuring the amount of tear production is an indispensable part of examination in such patients, and the most commonly used test is the Schirmer's test (ST). ST is routinely performed for 5 minutes and may cause minimal ocular discomfort and irritation to the patient. Unfortunately, the application of this test in medical practice is time-consuming and sometimes is inconvenient to the patient and physician alike. It has been suggested that 1-minute ST highly correlates with those of the 5-minute test. Jones and associates found that the mean value of 1-minute ST was almost one third of the 5-minute ST and recommended multiplying the 1-minute value by the factor of 3 to calculate the 5-minute ST. They, however, did not use any statistical analysis to accurately calculate such a correlation.

ST is most commonly performed with the patient’s eyes open and blinking normally. When the eyes are closed, the role of the lid margins and eyelashes in stimulating tear secretion and the influence of external factors such as temperature, evaporation, and humidity are reduced. Serin et al stated that the ST with the patient’s eyes closed produces less variable results in normal subjects.

It is not clear if a more comfortable (closed eye) and faster (1-minute) ST could be used to calculate the standard 5-minute open eye ST. This study was conducted to assess the results of 1-minute and 5-minute ST when the eyes are open (STo) and closed (STc) in normal subjects with the same age to find out if shorter duration (1-minute) and more comfortable state (STc) could be used to calculate the standard 5-minute STo.

**Methods**

Thirty-four healthy volunteers were included in the study. Inclusion criteria were normal ophthalmologic findings except for refractive errors, no use of contact lenses, no history of previous medical or ophthalmic problem, and no current use of medications. Right eyes of all patients were selected for the examination.

One examiner administered the tests on all patients. The value of Schirmer's I test was determined by measuring the length of the wetted part of the standardized filter paper strip (Whatman No. 41 and 5x60 mm) one and five minutes after inserting one end of the paper into the lateral side of the lower conjunctival fornix. The patient was instructed to keep the eyes open and blink normally during STo and to keep the eyes closed during STc. For each patient, STo and STc were performed separately with an interval of at least 24 hours.

Data were entered into the SPSS software (version 11.5, Chicago). The paired T-test, Kolmogorov-Smirnov test, and linear regression test were used for statistical analysis. A P-value less than 0.05 was considered statistically significant.

**Results**

Thirty-four eyes of 34 patients (19 female and 15 male) with a mean age of 20.8 (range: 18-23) years were enrolled in this study. Mean value of STc was significantly less than STo in both 1 minute and 5 minutes (Table 1). One-minute STo and STc showed a significantly less wetting than 5-minute test (Table 1).

Kolmogorov-Smirnov test showed that all the values are distributed normally (0.14<P<0.85, 0.60<Z<1.14). Linear regression analysis showed a significant correlation between 1-minute and 5-minute test in both STo (Correlation coefficient=0.88, P<0.0005, R square=0.77) and STc (Correlation coefficient=0.88, P<0.0005, R square=0.80) (Figure 1 and Figure 2). The following equations could be used to calculate the 5-minute ST from 1-minute ST value:

- 5-minute STo=1.67 (1-minute STo) + 10.2 (F=119.6, Residual=2478, P<0.0005)
- 5-minute STc= 1.74 (1-minute STc) + 9.4 (F=113.2, Residual=2787, P<0.0005)

The linear regression analysis did not show a good correlation between the most comfortable state (1-minute STc) and standard ST (5-minute STo) (correlation coefficient=0.63, R square=0.44) (Figure 3). Therefore, calculated 5-minute STo will only be correct in 44% of 1-minute STc, which is not acceptable.
Table 1. Results of open and closed eye, 1-minute and 5-minute Schirmer's test (ST) in 34 normal subjects

<table>
<thead>
<tr>
<th></th>
<th>Closed eye ST</th>
<th>Open eye ST</th>
<th>Confidence interval (CI)</th>
<th>P-value (T-test)</th>
</tr>
</thead>
<tbody>
<tr>
<td>One-minute</td>
<td>9.88±8.2</td>
<td>13.44±7.8</td>
<td>1.07- 6.04</td>
<td>0.006</td>
</tr>
<tr>
<td>Five-minutes</td>
<td>26.76±16.07</td>
<td>32.73±14.9</td>
<td>0.96- 12.10</td>
<td>0.004</td>
</tr>
</tbody>
</table>

Figure 1. Linear regression plot of the open eye 1-minute versus 5-minute Schirmer's test (ST)

Figure 2. Linear regression plot of the closed eye 1-minute versus 5-minute Schirmer's test (ST).
Discussion

Although ST is not the only test for the diagnosis of dry eye, it is one of the most common diagnostic tests that is used universally to support clinical evidence of this disorder.

Standard definitions of ST are based on the amount of wetting measured in 5 minutes with an open eye and without anesthesia. Using 5 minutes of wetting, however, is quite impractical as a simple and convenient tool in most ophthalmologists’ everyday practice. Closing the eyes during ST results in less blinking and may help to maintain more stable and uniform conditions under which the test is performed. It is also easier for the patient to keep the eyes still because external visual stimulants are absent, and this reduction in eye movements minimizes irritation caused by the paper. This in turn reduces excess reflex tearing, which is a major factor that compromises ST’s reliability. The statistically significant higher ST0 (1- and 5-minute) readings in our study support this increase in reflex tearing when the eyes are open during ST. Serin et al compared the repeatability of ST administered with the eyes open with the repeatability of the ST administered with the eyes closed. They found that administering the ST with the patient’s eyes closed produces less variable results and is more repeatable than ST0 in normal subjects.

Jones et al evaluated one and 5-minute ST0 in the right eyes of 18 normal subjects. They reported an average of 27.5 mm of wetting in 1 and 91.5 mm in 5 minutes and recommended that by multiplying the amount of wetting in 1-minute by a factor of 3, the results will be as acceptable as 5-minute test. However, their formula was simply based on the average amount of wetting without an accurate and reliable calculation using statistical tests for analysis. Bawazeer and Hodge found that shorter durations of the 5-minute ST specifically, the 1-minute test correlate highly with those of the 5-minute test. However, all of their patients had symptoms of dry eye syndrome.

This study aimed to find out if a shorter (1-minute) and/or more comfortable (STc) state of ST could be statistically reliable to calculate the standard 5-minute ST0. To obtain valid measurements with low inter-individual and intra-individual variability, we evaluated the results of ST in one and five minutes in the same people during the same
test in normal subjects. Each test was repeated with the open and closed eye with an interval of at least 24 hours. Our results showed a significant correlation between one and five minutes results in normal subjects. The ophthalmologist may simply calculate the results of 5-minute test from one minute test.

To calculate 5-minute ST results for both open and closed eyes, one may multiply the results of one-minute measurements by the factor of 1.7 and add 10 [5-minute ST=1.7 (1-minute ST) + 10]. The result will be correct in 77% of the open eye measurements and 80% of the closed eye measurements. However, the extracted formula for calculation of 5-minute STo from 1-minute STc will lead to correct results in only 44%. Without using complex statistical analysis, our results are similar to those found by Jones et al\(^4\) [5-minute STo=3 (one-minute STc)]. However, regression analysis extracted formula is, more precise and reliable.

Our study has some limitations. There is a narrow range of age for the subjects included in our study. Also, patients with dry eye conditions excluded from the study. These may decrease generalizability of our results. We recognize the need for further studies with broad inclusion criteria and age groups, comparing the results of various methods of the ST.

**Conclusion**

One-minute ST in both open and closed eyes is valuable alternative to conventional 5-minute ST. It provides faster and more comfortable measurements in normal subjects; however, it's effect on dry eye patient's requires complementary studies.

**References**