The Reproducibility of the Schirmer Test

Jin Hak Lee, M.D. and Pil Mok Hyun, M.D.

Department of Ophthalmology, College of Medicine, Seoul National University, Seoul, Korea

The Schirmer test was performed 1350 times in 110 normal individuals and 15 dry eye patients to investigate the significance of the test as a diagnostic method for dry eye. The reproducibility of the Schirmer test was 54.5% in normal individuals and 41.9% in dry eye patients. There was no difference in the reproducibility between the groups with topical anesthesia and those without it. The ratio of misdiagnosis by Schirmer test was 48.4%.

These results suggest that it is impossible to differentiate dry eye patients from normal individuals by the Schirmer test.

Key words: Schirmer test, dry eye, reproducibility, ratio of misdiagnosis.

INTRODUCTION

In spite of the existence of a large amount of data and various modifications of the Schirmer test, there have not been established normal values for the test with or without regard to topical anesthesia. Furthermore, there have also been a number of arguments as to whether the Schirmer test is a significant test for the diagnosis of dry eye syndrome or not.

Therefore, we proposed the following four questions concerning the Schirmer test and performed this study to resolve the questions.

1. Does topical anesthesia have any influence on the reproducibility of the Schirmer test?
2. How much is the Schirmer test score affected by different examiners?
3. How reproducible is the Schirmer test?
4. Is it possible for the Schirmer test to differentiate dry eye patients from normal individuals?

MATERIALS AND METHODS

Whatman No. 41 paper was precut into strips 5 mm and 35 mm in length. A notch was made 5 mm from the end of the strip. The strip was bent at the notch, and the 5 mm end was inserted into the lateral canthal area of the lower fornix with the eyes closed. The 30 mm segment was left to hang over the lower lid. In 5 minutes, the strip was removed and the wetted length was measured. The normal subjects were 110 individuals who had no ophthalmic disorders and no history of eye drops or systemic drug medication. We divided these individuals into the following three groups.

Group A (10 persons): Five different examiners performed the Schirmer test two times on the same individual, with and without 0.5% tetracaine anesthesia in at least 6 hour intervals.

Group B (20 persons): Five different examiners performed the test on the same individual with 0.5% tetracaine topical anesthesia in at least 20 minute intervals.

Group C (80 persons): One examiner performed the test on the same individual five times repeatedly with 0.5% tetracaine topical anesthesia in at least 20 minute intervals.

The dry eye patients were 15 individuals who had a tear film break up time of less than 5 seconds and at least 4 of the following 5 items; 1) symptoms of dry eye syndrome, 2) conjunctival follicle, 3) mucoid plug, 4) corneal erosion, or 5) relief of symptoms by instillation of artificial tears.
The dry eye patients were tested by the same methods as Group C, and were identified as Group D.

RESULTS

Influence of topical anesthesia on the reproducibility of the Schirmer test

The influence of topical anesthesia was investigated by comparing the mean differences between the maximum and the minimum and also by comparing the mean coefficients of variation in scores of five measurements with topical anesthesia with those without it (Table 1). There was no significant difference between them.

Table 1. Schirmer test scores in Group A

<table>
<thead>
<tr>
<th>Anesthesia</th>
<th>Mean scores (mm)</th>
<th>S.D.</th>
<th>MD</th>
<th>MCV (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>without</td>
<td>10.7</td>
<td>5.95</td>
<td>14.0*</td>
<td>68**</td>
</tr>
<tr>
<td>with</td>
<td>8.9</td>
<td>4.59</td>
<td>12.5*</td>
<td>64**</td>
</tr>
</tbody>
</table>

S.D.: standard deviation,
MD: mean difference between the maximum and the minimum in scores of five measurements
MCV: mean coefficient of variation in scores of five measurements,
*, **: not significant at p=.05

The errors by different examiners

Group B was compared with Group C for calculating the errors by different examiners. The mean differences between the maximum and the minimum in scores of five measurements were 11.0 mm and 7.5 mm in the tests by five examiners (Group B) and by one examiner (Group C), respectively. The mean coefficients of variation in scores of five measurements were 62% and 51% in Group B and Group C, respectively (Table 2).

Reproducibility of the Schirmer test

The reproducibility of the Schirmer test was calculated by comparing the scores of the first and the second examination with those of the third and the fourth, using the paired t-test in normal subjects (Group C) and dry eyes (Group D). The reproducibility of the Schirmer test was 54.5% in normal subjects and 41.9% in dry eyes (Table 3).

Table 3. The reproducibility of the Schirmer test in Group C and Group D

<table>
<thead>
<tr>
<th>Group</th>
<th>Reproducibility (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C (normal subjects)</td>
<td>54.5</td>
</tr>
<tr>
<td>D (dry eye patients)</td>
<td>41.9</td>
</tr>
</tbody>
</table>

The scores of five measurements of each individual by one examiner (Group C) were widely distributed in the range of the mean ±10% (Fig.1).

Fig. 1. The distribution of scores of five measurements by one examiner (Group C).
Rate of misdiagnosis by the Schirmer test

The false positives and the false negatives of the scores in this study were calculated based on the normal values of other authors' reports (Table 4). The reported normal cut off values except for Lamberts' showed too high a frequency of false positives, however Lamberts' value presented too high a frequency of false negatives.

The statistic rate of misdiagnosis by the Schirmer test was calculated, using the following formula.

\[
STM = P \left( | Z | > \frac{\mu_2 - \mu_1}{\sigma} \right)
\]

STM: statistic rate of misdiagnosis
\( \mu_2 \): mean score of Schirmer test in normal eyes (Group C)
\( \mu_1 \): mean score of Schirmer test in dry eyes (Group D)

The statistic rate of misdiagnosis by the Schirmer test was 48.4% when one examiner makes a diagnosis by one measurement, and 41.2% when one examiner makes a diagnosis based on an average of five measurements.

**DISCUSSION**

Topical anesthesia tends to decrease Schirmer test values by about 40 per cent when mean values of a large population are compared, and topical anesthesia may be thought to affect the reproducibility of the Schirmer test. But in this study, there was no significant difference in the coefficients of variation between the test with topical anesthesia and that without it. This indicates that topical anesthesia has no influence on the reproducibility of the Schirmer test.

The main handicap of the Schirmer test is its variability. One of the reasons for its variability is the inconstant surface size of the inserted portion of the Schirmer test strip. The larger this portion is, the more of a stimulant it is. The mean difference between the maximum and the minimum and the mean coefficients of variation in scores of five measurements were greater in the scores by five examiners than those by one examiner. This suggests that there is a significantly larger error in examinations by different examiners than repeated examinations by one examiner.

Because of its large variability, there have been many arguments as to whether the Schirmer test is reproducible or not. In this study, the reproducibility of the Schirmer test was 54.5% in normal individuals and 41.9% in dry eyes. This indicates that the Schirmer test is not very reproducible in either normal subjects or in dry eyes.

Schirmer\(^1\) reported that a normal cut off value of the Schirmer test was 15 mm wetting in 5 minutes without topical anesthesia. On the other hand, De Roeth\(^2\) and Van Bijsterveld\(^3\) reported a normal cut off value of 10 mm and 5 mm wetting in 5 minutes without topical anesthesia respectively. Even though topical anesthesia was given, the variability of the Schirmer test is also notorious. Jones\(^4\) reported the normal cut off value of 10 mm wetting in 5 minutes with topical anesthesia, and Lamberts\(^5\) reported a value of 3 mm wetting. In this study, the above criteria showed too a frequency of false positives or false negatives. This suggests that there is no available normal cut off value for the Schirmer test.

The rate of misdiagnosis of the Schirmer test was 4.8% when one makes a diagnosis by one measurement and 41.2% when one makes a diagnosis from an average of five measurements. If one differentiates dry eye patients from normal individuals by the toss of a coin, the rate of misdiagnosis will be 50%. Therefore, the Schirmer test is similar to the toss of a coin in the diagnosis of dry eye syndrome.

---

**Table 4. The rate of misdiagnosis by the Schirmer test based on other authors' normal values**

<table>
<thead>
<tr>
<th>Author</th>
<th>Normal value</th>
<th>Anesthesia</th>
<th>False positive (%)</th>
<th>False negative (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schirmer</td>
<td>&gt;15</td>
<td>(-)</td>
<td>66.7</td>
<td></td>
</tr>
<tr>
<td>De Roeth</td>
<td>&gt;10</td>
<td>(-)</td>
<td>45.6</td>
<td></td>
</tr>
<tr>
<td>Van Bijsterveld</td>
<td>&gt;5</td>
<td>(-)</td>
<td>34.4</td>
<td></td>
</tr>
<tr>
<td>Jones</td>
<td>&gt;10</td>
<td>(+)</td>
<td>62.2</td>
<td>16.0</td>
</tr>
<tr>
<td>Lamberts</td>
<td>&gt;3</td>
<td>(+)</td>
<td>9.7</td>
<td>68.0</td>
</tr>
</tbody>
</table>
REFERENCES
