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Correlation and reliability of the Zone-Quick Phenol Red Thread Tear Test to dry eye symptoms

Scott R. Lewis
Pacific University

Tara L. Pinske
Pacific University

G Shane Smith
Pacific University

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Abstract

Purpose: In the past, optometry has relied on such tests as the Schirmer Test to diagnose dry eye syndrome. New methods such as the Zone-Quick Phenol Red Thread Test (PRTT) have been developed to identify dry eye patients. This project is designed to test the correlation of the PRTT to dry eye symptoms as well as test/retest reliability.

Methods: Of 120 randomly chosen young, pathology free optometry students, 54 test subjects (108 eyes) were placed into either a control group or a symptomatic group based upon their responses to a detailed dry eye questionnaire. Both eyes were tested according to PRTT protocol, resulting in a wet thread length measurement in mm. Measurements of less than 10 mm were considered a "dry" result, while lengths 20 nun or greater were considered "normal."

Results: A statistically significant difference (p=0.003) in mean wet thread length was found between the two groups. Based on mean wet thread lengths, all 27 subjects in the control group were classified as "normal" by the PRTT, while only 2 of 27 subjects in the symptomatic group were correctly classified as "'dry." Intra-trial and inter-trial correlation testing was variable, ranging from r=0.19 to r=0.76.

Conclusions: The results of this study suggest that the PRTT may be inadequate as a diagnostic test for dry eye syndrome in the normal population. Statistical analysis revealed poor repeatability between trials and inconsistent correlation between eyes. The gold standard for accurate diagnosis of dry eye syndrome remains a detailed questionnaire combined with extensive case history.

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CORRELATION AND RELIABILITY

OF THE

ZONE-QUICK PHENOL RED

THREAD TEAR TEST

TO DRY EYE SYMPTOMS

By

SCOTT R. LEWIS

TARA L. PINSKE

G. SHANE SMITH

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Advisor:

Patrick J. Caroline, C.O.T., F.A.A.O

Faculty Advisor:

Patrick J. Caroline, C.O.T., F.A.A.O _____

Authors:

Scott R. Lewis _____

Tara L. Pinske _____

G. Shane Smith _____

Dean:

Leland Carr, O.D. _____

Shane Smith, a native Albertan, will receive the Doctorate of Optometry degree from Pacific University College of Optometry, 2000. He received a Bachelor of Science degree in Laboratory Medicine, University of Alberta, 1995 as well as a Medical Laboratory Technology Diploma, Northern Alberta Institute of Technology, 1994. He was awarded the Mobil Oil Canada Student Scholarship from 1989-1992. Shane is a member of the AOSA, BSK Optometric Honor Society, and Phi Theta Upsilon Optometric Fraternity. His future plans are for private practice in general Optometry.

Scott Lewis is a native Oregonian that attended Pacific University for both undergraduate and optometric studies. He received his Bachelor of Science degree from Pacific University in 1998. He will be graduating from optometry school in the spring of 2000. Scott is a member of numerous organizations, including the AOA, AOA Sports Vision section, and BSK International Optometric Honor Society. After graduation, he plans to practice optometry in the Northwest.

Tara Pinske, originally from Minnesota, attended undergraduate school at the University of Wisconsin, Superior, and received a Bachelor of Visual Science degree from Pacific University in 1998. She is a member of the AOSA, BSK Optometric Honor Fraternity, Phi Theta Upsilon Optometric Society, and is an active member of the Amigos Eye Care organization. After receiving her Doctorate from Pacific University in May of 2000, Tara plans to practice optometry in the western United States.

Correlation and Reliability of the Zone-Quick Phenol Red Thread Tear Test To Dry Eye Symptoms

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Key Words: Phenol Red Thread Test, Shirmer Tear Test, dry eye, questionnaire

INTRODUCTION

Dry eye is one of the most frequently encountered conditions in today's optometric practice. Presently, no single objective standardized test exists for diagnosis of this condition. For this reason, a thorough case history that stresses patient symptoms, in conjunction with a careful examination of external ocular structures, is the optometrist's best means of diagnosis. With this information, and results of tear stability and tear quantity testing, an assessment of type, severity, and epidemiology of dry eye may be made for the appropriate treatment regimen.

Dry eye is currently classified into two categories: evaporative and tear deficient. Evaporative dry eye is a result of deficiencies or abnormal production by either the goblet cells of the conjunctiva (affecting the lipid layer of the tears), or, most often, the meibomian glands (which produce the oily layer of the tears). Tear deficiency dry eye is most commonly found in females in their fifth decade of life and is often due to autoimmune disease such as Sjogren's syndrome and rheumatoid arthritis, which affect aqueous secretion.

In the past, the Schirmer test has been commonly used to assess the severity of dry eye caused by tear deficiency. However, many studies have found the Schirmer test to have variable results and poor reliability.[2,3,4] In 1997, Schein et al; used a standardized questionnaire to evaluate dry eye symptoms in patients 65 years of age and older. Of the 14.6% who were symptomatic, only 2.2% had a Schirmer test result of less than or equal to 5. Little correlation was found between the Schirmer test results and symptoms identified by the questionnaire.[5]

The phenol red thread test (PRTT) was invented in 1982 in an attempt to overcome the poor reliability and variable results found with the Schirmer test. A study by Chaing, et al. proved the PRTT to be more statistically reliable with less variable results than the Schirmer test, especially for dry eye patients.[6] However, no testing has been done to correlate PRTT results with subjective patient symptoms as has been done with the Schirmer test.[5] Also, few studies have been performed to test reliability of the PRTT.

This study was designed to test the association of PRTT results with dry eye symptoms and to examine the reliability of the PRTT.

METHODS

120 optometry students were asked to evaluate their dry eye symptoms via a detailed questionnaire. In this questionnaire, the subjects were asked whether or not they felt that they had a problem with dry eye. A "Yes" answer was scored at 5 points and a "No" answer was scored at zero points. The next question involved rating the severity of these perceived dry eye problems on a scale of 1 to 5. Points were given according to the rating circled, with 1 being worth 1 point, 2 worth 2 points, etc. Patients with no subjective dry eye symptoms were assigned a point value of zero.

A list of twenty symptoms was then provided and subjects were asked to rank the frequency of each symptom as they experienced it. An answer of "Never" was assigned zero points, "Seldom"(1-2x/month) was scored at 1 point, "Sometimes"(1-2x/wk)= 2 points, "Often"(min.2x/wk)= 3 points, and "Constant" was scored at 4 points.

These numbers were then added and two groups were formed. A score of 20 or less was used to define the asymptomatic group, as this would allow the "asymptomatic" subjects to experience each of the 20 symptoms on a "Seldom" basis, which may be regarded as normal. Subjects who scored at 26 or higher were grouped into the symptomatic category. Those whose scores fell into the 21-25 scoring range were considered borderline and were excluded from further testing.

SUBJECT SELECTION

Based upon questionnaire responses, 54 subjects were randomly chosen from a young, pathology free student population for the study, with 27 subjects forming each group. The symptomatic group was composed of 13 males and 14 females; mean age was 25.7 years. Of the symptomatic subjects, 59% had been previously diagnosed with dry eye using other means of assessment such as Schirmer test and Tear Break Up Time (TBUT). In the symptomatic group, 44% were currently taking pharmaceutical agents known to cause dry eye such as oral contraceptives and antihistamines; 23 out of the 27 subjects were regular contact lens wearers.

The asymptomatic group was composed of 15 males and 12 females; mean age was 24.3 years. In this group, 7.4% had been previously diagnosed with dry eye and had received treatments such as punctal plugs. Only 18.5% were taking pharmaceuticals with known dry eye sideeffects; 16 out of the 27 subjects were regular contact lens wearers. No systemic or anterior segment disease was noted for subjects in either group.

Phenol red thread testing was conducted at the same of day on two separate occasions in a climate controlled room. All subjects were asked to refrain from wearing contact lenses for 24 hours prior to testing and from using ocular lubricants on the day of testing.

Testing was performed on both eyes, following the Zone Quick Phenol Red Thread testing protocol as follows: the folded 3 mm end of the thread was placed approximately 1/3 of the distance from the lateral canthus of the lower eyelid with the eye in primary position. The lid was pulled down slightly to allow for placement on the lower palpebral conjunctiva. The patient was instructed to keep both eyes open and blink normally during the 15-second interval, which was timed with a stopwatch. The lid was then gently pulled down and the thread removed with an upward motion. The entire wetted length of the thread was measured in millimeters, including the folded portion. Measurements of less than 10 mm were considered a "dry" result, while lengths 20 mm or greater are consider "normal." This same procedure was followed in the second trial one week later.

RESULTS

The Phenol Red Thread Test (PRTT) results for each group of subjects were analyzed statistically to determine if any difference existed in mean wetted thread lengths. Using the t-test, a statistically significant difference (p=0.003) was found between the groups. The mean wetted thread length for the control group was 22 mm (SD=5.4), while the mean wetted thread length for the test group was 18 mm (SD=5.1).

As per PRTT protocol, a result of 10 mm or less is classified as "dry" while a result of 20 mm or greater is classified as "normal." All of the asymptomatic group had mean measurements greater than 10 mm; 7 subjects had results between 11 and 19 mm, and 20 subjects had results 20

mm or greater. Thus all of the asymptomatic subjects would be classified as normal by the PRTT.

In the symptomatic group, only 2 subjects had PRTT results of 10 mm or less. Thus the PRTT correctly identified only two of the dry eye subjects, as determined by the questionnaire, and missed 25 of them.

Pearson correlation testing between OD and OS results on the same day, for both groups, ranged from r=0.53 to 0.67. Similar results were obtained for OD only, separate days (r=0.19 to 0.56) and OS only, separate days (r=0.61 to 0.76). Based upon on our results, using standard PRTT testing protocol, the PRTT has poor sensitivity, with a 92.6% false negative rate and marginal repeatability.

DISCUSSION

Unlike prior projects, this study used a detailed questionnaire to differentiate subjects into two groups - those with and those without significant subjective dry eye symptoms. This survey incorporated questions about history and subjective symptoms in a manner similar to the questionnaire previously standardized by McMonnies.[6] Additionally, our survey probed most ocular symptoms associated with dry eye. This detailed questionnaire was successful in categorizing those subjects with symptoms, as evidenced by the fact that all previously diagnosed dry eye patients were placed into the symptomatic group.

The results of this study suggest that the PRTT may be inadequate as a diagnostic test for dry eye in the test population due to its inability to objectively differentiate symptomatic from asymptomatic subjects. Although a statistically significant difference exists between the mean PRTT results for symptomatic and asymptomatic patients, the difference is not large enough to be clinically significant.

The secondary objective of this study was to determine whether the PRTT showed test/retest reliability and consistency for data from the two eyes. Statistical analysis showed fair to poor correlation between eyes tested on the same day (r=0.53 to 0.67), and between the same eye

measured in different trials (OD r=0.19 to 0.56, OS r=0.61 to 0.76). This is in agreement with a recent study by Kinney that found the PRTT to have up to a 16mm difference between visits.[7]

There are many factors to consider in making a diagnosis of dry eye. Before examining the tear layer, lid disease must be considered, especially if the patient is a contact lens wearer. Horn found that up to 40 percent of contact lens patients with dry eye had meibomian gland dysfunction.[8] Systemic pathology as a causative agent of dry eye must also be considered. Autoimmune diseases such as Sjogren's and rheumatoid arthritis are known to cause aqueous-deficiency. Finally, the age of the patient must also be considered, since tear production and quality are known to decrease with age.[9]

The repeatability of the PRTT is questionable, negatively affecting the diagnostic value of the test. However, it still may have value as a supplemental test. The PRTT also has value in its ability to visually reinforce poor aqueous production to patients. Our study results indicate that in a young, pathology-free population of subjects symptomatic for dry eye, PRTT results do not correlate well with subjective symptoms. The results also suggest that the most important tool in the diagnosis of dry eye is still a thorough case history, utilizing an appropriate detailed questionnaire.

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PHENOL RED THREAD TEST RESULTS(mm)

Results accurate to +/- 1mm

CTRL=CONTROL GROUP
DE=DRY EYE GROUP
QUEST=QUESTOINNAIRE

SUBJECT	CTRL OD TRIAL1	CTRL OS TRIAL 1	CTRL OD TRIAL 2	CTRL OS TRIAL 2	CTRL AVE
1	23	24	21	19	22
2	17	18	22	20	19
3	24	28	25	29	27
4	26	27	24	29	27
5	20	17	18	19	19
6	28	25	27	26	27
7	22	23	20	23	22
8	27	25	23	22	24
9	22	22	25	30	25
10	22	25	18	23	22
11	17	19	13	12	15
12	24	25	26	24	25
13	25	20	24	22	23
14	23	25	22	22	23
15	15	14	18	16	16
16	25	25	19	22	23
17	20	28	24	25	24
18	20	17	24	12	18
19	13	21	15	22	18
20	17	21	20	23	20
21	23	26	22	24	24
22	21	22	23	24	23
23	20	22	28	27	24
24	22	20	20	22	21
25	23	15	23	17	20
26	12	12	20	7	13
27	23	23	24	29	25

	CTRL OD TRIAL1	CTRL OS TRIAL 1	CTRL OD TRIAL 2	CTRL OS TRIAL 2	CTRL AVE
AVE	21	22	22	22	22
STD DEV	4.0	4.3	3.5	5.5	3.6
95% CI	1.5	1.6	1.3	2.1	1.4

Ttest (p value)
DeAve vs. CtrlAve

	0.003				

Pearson Correlation

b\w OD&OS Same trial	0.65		0.53		
OD only Separate trials	0.56				
OS only Separate trials		0.76			

SUBJECT	CTRLQUESTSCORE	Diff ctrl od1-od2	Diff ctrl os1-os2	Diff ctrl od1-os1	Diff ctrl od2-os2
1	16	2	5	1	2
2	18	5	2	1	2
3	20	1	1	4	4
4	16	2	2	1	5
5	9	2	2	3	1
6	5	1	1	3	1
7	6	2	0	1	3
8	7	4	3	2	1
9	17	3	8	0	5
10	4	4	2	3	5
11	6	4	7	2	1
12	3	2	1	1	2
13	7	1	2	5	2
14	8	1	3	2	0
15	4	3	2	1	2
16	15	6	3	0	3
17	19	4	3	8	1
18	7	4	5	3	12
19	4	2	1	8	7
20	7	3	2	4	3
21	7	1	2	3	2
22	6	2	2	1	1
23	7	8	5	2	1
24	12	2	2	2	2
25	14	0	2	8	6
26	14	8	5	0	13
27	16	1	6	0	5
AVE	10	3	3	3	3
STD DEV	5.4	2	2	2	3
95% CI	2.0	0.8	0.7	0.9	1

SUBJECT	DE OD TRIAL 1	DE OS TRIAL 1	DE OD TRIAL 2	DE OS TRIAL 2	DE AVE
1	30	25	5	20	20
2	12	24	16	16	17
3	21	17	15	8	15
4	21	25	16	16	20
5	28	30	24	22	26
6	11	20	11	9	13
7	11	17	17	19	16
8	7	7	9	9	8
9	8	4	16	7	9
10	14	14	25	22	19
11	20	20	29	24	23
12	21	17	17	19	19
13	17	13	5	9	11
14	20	23	30	25	25
15	23	21	17	16	19
16	12	15	16	6	12
17	6	16	15	16	13
18	14	12	15	19	15
19	24	24	17	28	23
20	21	15	18	21	19
21	27	29	16	27	25
22	24	20	26	23	23
23	22	24	24	24	24
24	22	9	16	17	16
25	12	12	21	16	15
26	19	15	11	17	16
27	24	26	22	27	25
AVE	18	18	17	18	18
STD DEV	6.6	6.6	6.3	6.5	5.1
95% CI	2.5	2.5	2.4	2.4	1.9

Pearson Correlation					
b\w OD&OS Same trial	0.67		0.57		
OD only Separate trials	0.19				
OS only Separate trials		0.61			

SUBJECT	DEQUESTSCORE	Diff de od1-os1	Diff de od2-os2	Diff de od1-od2	Diff de os1-os2
1	45	5	15	25	5
2	68	12	0	4	8
3	45	4	7	6	9
4	36	4	0	5	9
5	40	2	2	4	8
6	26	9	2	0	11
7	52	6	2	6	2
8	28	0	0	2	2
9	26	4	9	8	3
10	29	0	3	11	8
11	29	0	5	9	4
12	58	4	2	4	2
13	30	4	4	12	4
14	30	3	5	10	2
15	26	2	1	6	5
16	63	3	10	4	9
17	27	10	1	9	0
18	38	2	4	1	7
19	32	0	11	7	4
20	32	6	3	3	6
21	30	2	11	11	2
22	49	4	3	2	3
23	41	2	0	2	0
24	29	13	1	6	8
25	42	0	5	9	4
26	26	4	6	8	2
27	33	2	5	2	1
AVE	37	4	4	7	5
STD DEV	11.9	4	4	5	3
95% CI	4.5	1	1	2	1