



## The effect of pregnancy on tear osmolarity

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### ABSTRACT

**Objective:** To examine the effect of pregnancy on the lacrimal system through tear osmolarity measurement and the Schirmer test.

**Material and Method:** The study consisted of two groups of 30 women between 20 and 40 years old; the women in the study group were in their first trimester of pregnancy, and the women in the control group were not pregnant and did not have any diseases other than refractive error. Tear osmolarity measurement with the TearLab osmolarity system and tear function test Schirmer 1 were carried out on one, randomly chosen eye of each participant. The pregnant women's measurements were repeated on the same eye in their last trimester.

**Results:** The study group's first trimester tear osmolarity measurement was  $304.9 \pm 8.0$  mOsm/L, while their last trimester tear osmolarity measurement was  $300.2 \pm 7.1$  mOsm/L and the control group's was  $306.3 \pm 6.2$  mOsm/L. There was a statistical difference between the study group's first and last trimester results and between the study group's last trimester and the control group's results ( $p < 0.05$ ). The Schirmer test results were  $18.1 \pm 6.3$  mm for the study group's first trimester,  $16.6 \pm 6.9$  mm for the last trimester and  $21.3 \pm 9.0$  mm for the control group. There was a statistically significant difference between the study group's last trimester results and the control group's Schirmer test results ( $p < 0.05$ ).

**Conclusion:** Both the tear osmolarity values and Schirmer values were found to decrease significantly towards the end of pregnancy. These results suggest that decrease in both test results may play a protective role in the ocular surface during pregnancy.

### 1. Introduction

Pregnancy causes changes in many of the body's systems, including the ocular system. The changes in the ocular system can be physiological, such as a decrease in intraocular pressure, defects in the visual field, intolerance to contact lenses and/or melasma on the eyelid [1], or pathological, such as the advancement of diabetic retinopathy, the growth of pituitary adenoma and changes caused by preeclampsia and eclampsia [2–4]. Pregnancy can influence tear physiology and cause dry eye complaints [5]. This situation is thought to be associated with the hormonal changes in pregnancy [6].

The purpose of our study was to measure tear osmolarity and Schirmer test values in healthy pregnant women and to examine the influence of pregnancy on tear osmolarity and the symptoms of dry eye.

### 2. Material and method

This study was performed at Ondokuz Mayıs University, Turkey, in the Faculty of Medicine, Department of Ophthalmology, as a

prospective case-control study. The study consisted of two groups of 30 women between 20 and 40 years old; the women in the study group were in their first trimester, and the women in the control group were not pregnant and did not have any diseases other than refractive error. These two groups will be referred to as the study group (pregnant women) and the control group (non-pregnant women). A complete ophthalmologic examination, including refraction, was performed on both groups. Tear osmolarity with the TearLab osmolarity system and the tear function test Schirmer 1 were carried out on one, randomly chosen (left or right) eye of each participant. The tests were repeated on the study group in the women's last trimester to obtain comparable measurements from the same eye in the first and last trimesters. The measurements obtained were assessed and compared statistically between both groups and between both trimesters in the study group. The study's content and purpose were explained to all of the participants, and the author received signed informed consent forms from all participants.

The participants' were asked about any ocular surface symptoms, their best corrected visual acuity (BCVA) was determined according to

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the Snellen line, a detailed anterior segment examination was performed, osmolarity testing and the Schirmer Test were carried out and a fundus examination was performed. To avoid reflex tears, the osmolarity and Schirmer tests were first applied after anamnesis. The osmolarity measurement was taken first, and the Schirmer Test was conducted 30 min later; any other procedures were then performed. Any participants who used contact lenses, had an anterior segment deformity, had a diagnosed ocular surface disease, had excessive make up, or had significant irritation were not included in the study.

### 2.1. Technique

Tear osmolarity was measured with a TearLab Osmolarity device (TearLab Corporation, San Diego, CA, USA.). In order to check whether the system worked accurately, TearLab electronic control cards and normal or high osmolarity control solutions were used every day. A single use test card was placed on the probe. The Number 12 test card was used in all cases. A beep sound showed that the card had been inserted correctly, and a green light on the probe meant the measurement could be started. The protective lid on the card was removed. Tears were collected from the participants' lower lateral meniscus in the sitting position, with their chins uplifted and their eyes directed to the ceiling. The test card collects approximately 50 nanolitres of tears with its passive capillary effect. When a beep sound indicated that enough tears had been collected, the probe was placed in the reader. The code on the test card was entered in the reader, and the result of the measurement was displayed on the screen.

The Schirmer test was performed using a Schirmer strip (Schirmer Tear Test Ophthalmic Strips, Tarun Enterprises, India). Topical anaesthesia was not used because the participants were pregnant. The Schirmer test paper was folded from the notch line and placed in temporal one third of the lower eyelid. The participant was asked to blink normally. The Schirmer strip was removed after 5 min, and the result was recorded. Measurements of more than 35 mm within 5 min were recorded as 35 mm.

The first and last trimester osmolarity and the Schirmer values of the study group were statistically compared within the group itself and with the control group.

### 2.2. Statistical analysis

The data were entered and analysed in the IBM SPSS V.21 (Chicago, USA) program. The 'Kolmogorov Smirnov Test' was used to analyse whether the data were normally distributed. In the comparison of paired data that were normally distributed, the parametric method 'paired two sample *t*-test' was used; for data that were not normally distributed, the 'Wilcoxon Signed Rank Test' was used. In the comparison of the two independent groups, an 'independent two sample *t*-test' was used for normally distributed data, while the 'Mann-Whitney U Test' was used for not normally distributed data. In the correlation analysis between the variables, 'Spearman's Rank Correlation Test' was used since the data were not normally distributed. Results were shown as arithmetic average  $\pm$  standard deviation and median (min-max). The level of significance was taken as 0.05.

**Table 1**

Comparison of tear osmolarity and Schirmer test results measured in the study group's first and last trimester.

	First trimester group	Last trimester group	P value <sup>a</sup>
Tear osmolarity (mOsm/L) (mean $\pm$ SD / median(min-max))	304.9 $\pm$ 8.0 / 303.5 (291–323)	300.2 $\pm$ 7.1 / 301.0 (286–313)	0.003
Schirmer test (mm) (mean $\pm$ SD / median(min-max))	18.1 $\pm$ 6.3 / 16.5 (9–35)	16.6 $\pm$ 6.9 / 16 (8–35)	0.291

<sup>a</sup> Paired two sample - test ( $p < 0.05$ ), mOsm/L: milliosmols/litre, mm: millimeter.

## 3. Results

The study consisted of a study group of 30 pregnant women without any ocular or systemic diseases and a control group of 30 non-pregnant women without any ocular and systemic diseases except refractive error. The mean age of the study group was  $30.06 \pm 4.4$  years, while the mean age of the control group was  $25.80 \pm 4.8$  years. The mean time of the first measurement was 10.50 (6–13) weeks, and the mean time of the last measurement was 30.00 (28–35) weeks in the study group. The BCVA of the study and the control group was 20/20 Snellen line. Anterior segment and fundus examinations of both groups were normal.

The average tear osmolarity measurement of the first trimester pregnant women was  $304.9 \pm 8.0$  mOsm/L, and the median was 303.5 (291–323) mOsm/L; the last trimester average tear osmolarity measurement was  $300.2 \pm 7.1$  mOsm/L, and the median was 301.0 (286–313) mOsm/L; and the control group's average tear osmolarity measurement was  $306.3 \pm 6.2$  mOsm/L, and the median was 307.0 (293–323) mOsm/L. There was a statistical difference between the first trimester and last trimester tear osmolarity measurements of the study group ( $p < 0.05$ ). Osmolarity measurements of the study group's first trimester and those of the control group were not statistically significant ( $p > 0.05$ ). There was a statistical difference between the tear osmolarity measurements of the study group's last trimester and those of the control group ( $p < 0.05$ ).

The first trimester Schirmer test average was  $18.1 \pm 6.3$  mm, and the median was 16.5 (9–35) mm; the last trimester Schirmer test average was  $16.6 \pm 6.9$  mm, and the median was 16.0 (8–35) mm; and the control group's Schirmer test mean value was  $21.3 \pm 9.0$ , and the median was 18.5 (8.0–35.0) mm. No statistically significant difference was found between the study group's first trimester and last trimester Schirmer test measurements ( $p > 0.05$ ). The differences in the Schirmer test measurements of the control group and those of the study group's first trimester were not statistically significant ( $p > 0.05$ ). There was a statistically significant difference between the Schirmer test measurements of the control group and those of the study group's last trimester ( $p < 0.05$ ). Tables 1–3 summarize these statistical comparisons.

Figs. 1 and 2 show the osmolarity values and Schirmer test results of the control group and the study group's first trimester and last trimester.

During the study, ocular complaints were seen in only two pregnant women. One described seeing black points in front of her eye, and she was found to have posterior vitreous detachment. The second pregnant woman described visual blurriness, which lasted a few seconds and was found to occur due to orthostatic hypotension. No problems arose in the follow-up.

## 4. Discussion

Pregnancy influences a great number of systems in the body, including the lacrimal system. Hormonal changes can influence the lacrimal system and cause dry eye symptoms in this period [5]. Low androgen and high oestrogen in the serum is a risk factor for dry eye [7]. Some research has explored lacrimal changes and the tendency for

**Table 2**  
Comparison of tear osmolarity and Schirmer test results of the study group's first trimester and the control group.

	First trimester group	Control group	P value
Tear osmolarity (mOsm/L) (mean ± SD / median (min-max))	304.9 ± 8.0 / 303.5 (291-323)	306.3 ± 6.2 / 307 (293-323)	0.443 <sup>†</sup>
Schirmer test (mm) (mean ± SD / median (min-max))	18.1 ± 6.3 / 16.5 (9-35)	21.4 ± 9.3 / 18.5 (8.0-35.0)	0.213 <sup>**</sup>

<sup>†</sup> Independent two sample t-test (p < 0.05).  
<sup>\*\*</sup> Mann-Whitney U Test (p < 0.05), mOsm/L: milliosmols/litre, mm: millimetre.

**Table 3**  
Comparison of tear osmolarity and Schirmer test results of the control group and the study group's last trimester.

	Last trimester group	Control group	P value
Tear osmolarity (mOsm/L) (mean ± SD / median (min-max))	300.2 ± 7.1 / 301.0 (286-313)	306.3 ± 6.2 / 307 (293-323)	0.001 <sup>†</sup>
Schirmer test (mm) (mean ± SD / median (min-max))	16.6 ± 6.9 / 16 (8-35)	21.4 ± 9.3 / 18.5 (8.0-35.0)	0.03 <sup>**</sup>

<sup>†</sup> Independent two sample t-test (p < 0.05).  
<sup>\*\*</sup> Mann-Whitney U test (p < 0.05), mOsm/L: milliosmols/litre, mm: millimetre.

dry eye in pregnancy.

Ding et al. (2011) performed the Schirmer test, breakup-time of tear (BUT) and Rose Bengal tests on pregnant and non-pregnant rabbits, and they assessed their ocular surface health. The Schirmer test and BUT results were significantly lower in the pregnant rabbit group than they were in the control group (p < 0.05) [8].

Wong et al. (2004) reported increased dry eye symptoms in pregnancy. Fifty one pregnant women in their last trimester and 33 non-pregnant women were included in this study. A questionnaire was given to women to assess dry eye [9].

Skare et al. (2012) conducted the Schirmer 1 test on and distributed

a dry eye symptom questionnaire to 150 pregnant and 150 non-pregnant women. The groups were found to be similar [10].

In a study conducted by Ibraheem et al. on 165 healthy pregnant and 105 non-pregnant women, visual acuity, tear break up time, Schirmer test and intraocular pressure were assessed. The Schirmer reading was significantly lower in the healthy pregnant women group than it was in the control group [11].

In this study, a non-anesthetic Schirmer 1 test and tear osmolarity measurements were made to assess tears in a study group and a control group. While there was an average of a 1.5 mm decrease in the Schirmer readings between the first and the last trimester measurements, this decrease was not significant. However, the Schirmer test results were found to be significantly lower in the last trimester than they were in the control group. This result seems to be in parallel with some studies in the field.

The Schirmer test is one of the most widely used tests to assess tear production. However, it has disadvantages such as low reliability and repeatability [12]. It is useful in the diagnosis of dry eye; however, it is not sufficient on its own. For this reason, it is often used in conjunction with fluorescein staining, tear break up time, tear meniscus assessment and, recently, with other methods such as tear osmolarity measurement.

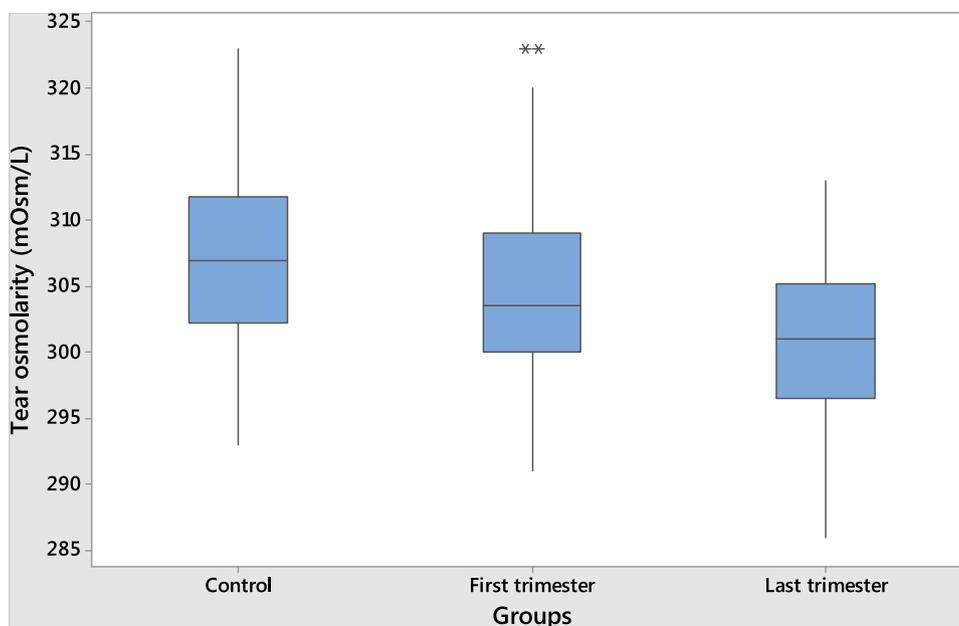
High tear osmolarity is associated with dry eye [13]. In the International Dry Eye Workshop in 2007, tear hyperosmolarity was stated to have a role in dry eye pathogenesis [14].

Tests other than osmolarity were used in a large number of studies in the literature on tear in pregnancy. In this study, tear osmolarity was used in the pregnancy.

Lemp showed that tear osmolarity measurement is a more sensitive and specific diagnostic test in assessing the state of the meibomian gland than the Schirmer test, tear break up time, conjunctival or corneal staining are [15].

In the current study, Schirmer test results and tear osmolarity results were found to be significantly lower in the last trimester pregnant women than they were in the control group. Decreases in both seem to provide the protection of ocular surface physiology in pregnant women.

In their study, Messmer et al. compared the tear osmolarity measurements of a dry eye group and a healthy control group with the TearLab system. They found the mean tear osmolarity result of the control group was 307.1 ± 11.3 mOsm/L, and the mean tear osmolarity result of the dry eye group was 308.9 ± 14.0 mOsm/L. No



**Fig. 1.** Comparison of the tear osmolarity values of the study group's first and last trimester and the control group.

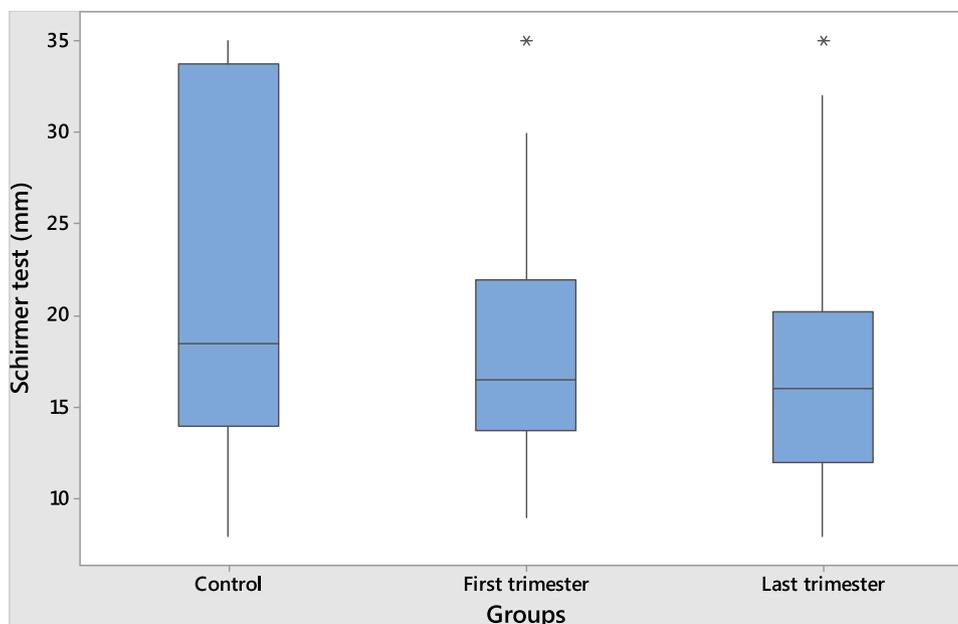


Fig. 2. Comparison of the Schirmer test values of the control group and the study group's first and last trimester measurements.

significant difference was found between the two groups [16].

Two significant results of this study were the decrease in both osmolarity and Schirmer value with the advancement of pregnancy. The decrease in Schirmer readings shows a decrease in the amount of aqueous, which generally causes an increase in the level of osmolarity. However, osmolarity levels also decreased in this study. The statistical significance between osmolarity values seems to be stronger than it is for the Schirmer test. Because p value between osmolarity results was  $p = 0.003$  for the first-last trimester,  $p = 0.001$  for the last trimester-control and  $p = 0.03$  for the last trimester-control Schirmer test, the authors conclude that osmolarity decreased during pregnancy. However, the authors could not explain the mechanism.

One of the limitations of our study is the use of only osmolarity measurement and the Schirmer test. However although the transmission from the conjunctiva to the body blood circulation is minimal, the authors avoid using local anaesthetics and fluorescein in the first trimester. Another limitation is that seasonal differences between the testing in the first and in the third trimester may have some effects on dry eye.

This study shows that tear osmolarity values and Schirmer test values decreased during pregnancy. With the decrease in the amount of aqueous, dry eye symptoms are expected to increase during pregnancy. However, significant symptoms found in a few pregnant women bring to mind that some unexplained balancing mechanisms protect the ocular surface in pregnant women. According to the results of this study, a decrease in osmolarity can be considered one of these mechanisms. Complicated system changes and the disrupted ocular surface balance during pregnancy seem to be compensated for with another change. However, the issue needs further investigation with new studies conducted with more extensive groups.

#### Declaration

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