Tear secretion and ferning patterns among premature and full-term newborns

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SUMMARY: Beden Ü, Turgut-Çoban D, Aygün C, Ulu-Güngör İ, Süllü Y, Erkan D, Küçüködük Ş. Tear secretion and ferning patterns among premature and full-term newborns. Turk J Pediatr 2008; 50: 155-159.

In this study, we aimed to assess the quality and quantity of tears among premature and term newborns. Tear ferning and Schirmer's tests were conducted over the first 10 days of life. Correlations between tear ferning patterns, Schirmer's scores, post-conceptional age, and birth weight were evaluated. Forty-six newborns (23 preterm, 23 term) were enrolled, with a mean post-conceptional age of 36.6 weeks and a mean weight of 2598.2 g. Mean total, basal and reflex Schirmer's test results were 13.5 mm, 6.7 mm and 6.8 mm, on the right and 14.0 mm, 7.1 mm and 6.9 mm on the left eye, respectively. Median ferning score was 2 (range 1-3) bilaterally. Schirmer scores were correlated with ferning capacity and post-conceptional age. Our study shows that newborns secrete moderate quantity, good quality tears. Ferning capacity, Schirmer scores and post-conceptional age are correlated.

Key words: newborn, premature, tear secretion, ferning, Schirmer.

The ferning phenomenon is a dendritic growth pattern of dried tear fluid. Its pattern is influenced by the electrolyte, protein and mucus contents of secretions. Initially developed by Papanicolau[1] and utilized in gynecology, this test more recently has been used to assess the quality of tear mucus, based upon the pioneering studies of Tabbara and Okumoto[2].

Despite there being many published studies concerning tear production in newborns, tear ferning pattern has not been investigated in premature or even term newborns. Moreover, studies of human tear secretion in term and premature newborns, by means of Schirmer's test, have yielded conflicting results[3-5]. Consequently, in this study we aimed to assess the mucus quality and secretion potential of premature and term babies' tears, using both mucus ferning and Schirmer's tests, and to explore any correlation between these two techniques.

Material and Methods

After obtaining informed consent from families, 23 preterm and 23 term newborns were included in the study. Babies with systemic and ocular anomalies or with local or systemic infections were excluded from the study.

Tear ferning and Schirmer's tests were performed during the first 10 days of life and while babies were in a quiescent state. Basal and reflex Schirmer's measurements and tear ferning tests were used to evaluate tear quality.

In order to assess ferning capacity, a few microliters of tear fluid was collected using an osmotic tube, blown onto a light microscopy slide, and then allowed to dry by evaporation at room temperature. Mucus crystallization was observed within 10 minutes of collection, using a light microscope at 40x magnification. This process was performed without applying any topical medication and before Schirmer's

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test measurements, in order to prevent any alteration in tear composition or ferning pattern. The ferning patterns were classified according to a grading system proposed by Rolando[6] (Fig. 1). In this system, Type I and II patterns are seen in normal tears and classified as good ferning capacity, while type III and IV patterns are seen in abnormal tears and classified as poor ferning capacity.

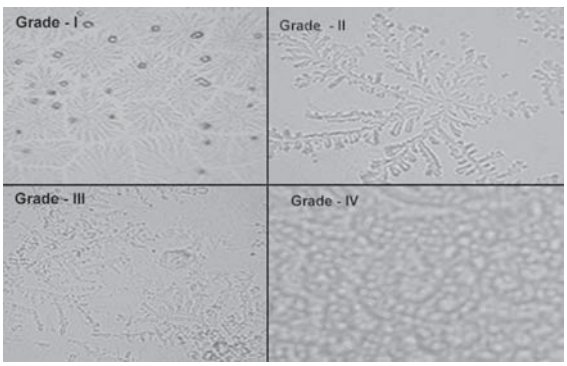

Fig. 1. Ferning patterns according to Rolando's classification scheme (light microscopy x 40).

After an assessment of ferning pattern, a sterile Schirmer's test strip was placed in both eyes in the inferotemporal conjunctival fornix, avoiding contact with the cornea. After five minutes, the strips were removed and wetting was measured in millimeters and recorded as total (basal + reflex) tear secretion. In order to measure basal tear secretion, a drop of topical anesthetic agent (Oxybuprocain 0.4% Thilo, Alcon, Belgium) was instilled in both eyes and the measurements were repeated. Reflex tear secretions were then calculated as the difference between total and basal Schirmer's results.

Chi-square, Student's t test, and Pearson correlation analyses were used for statistical analysis. A p-value of <0.05 was considered statistically significant. Correlation was described as weak, moderate, strong, and very strong when correlation coefficient (r) was 0.000 to 0.250, 0.250 to 0.500, 0.500 to 0.750, and 0.750 to 1.000, respectively.

Results

The clinical characteristics of 46 babies enrolled in the study are summarized in Table I.

The mean basal, reflex and total Schirmer's test results for the right and left eyes are presented in Table II. There was a very strong correlation between all the Schirmer's scores in the right and left eye ($p<0.001$), and a moderate correlation between Schirmer's scores and post-conceptional age ($p<0.05$). Birth weight was also moderately correlated with basal and total ($p<0.05$), but not with reflex ($p>0.05$) Schirmer's scores.

Schirmer's scores for both eyes and in both term and preterm babies are given in Table II, and in Figures 2 and 3. These results show that the total and basal Schirmer's test results are significantly different in term and preterm babies, while the reflex Schirmer's scores are not. The reflex secretion level was also higher in the terms, albeit not to a degree that was statistically significant.

During the ferning pattern evaluation, bilateral lacrimal sampling was performed on 36 babies, but only unilateral lacrimal sampling on 10 babies due to the loss of a quiescent state, in order to obviate the effect that crying could have on tear composition and ferning capacity. The ferning results for both eyes, in both term and preterm babies, are given in Table III. Out of 82 eyes among 46 patients, 77 (94%) showed good ferning capacity (Grade 1 or 2), in accordance with the system proposed by Rolando[6].

The ferning test was neither affected by the sex of the baby nor the time interval between birth and the test, while it was weakly correlated with all the Schirmer's scores ($p<0.003$).

Table I. Clinical Characteristics of the Babies Enrolled in the Study (values given as means ± SD [min–max])

	Preterm (n=23)	Term (n=23)	Total (n=46)
Male/female (%)	14/9 (61/39)	17/6 (74/26)	46
Post-conceptional age (weeks)	33.7±1.9 (30-37)	39.5±0.8 (38-41)	36.6± 3.3 (30-41)
Birth weight	2047.0±497.1 (1240-3260)	3149.5±707.8 (1750-4620)	2598.2±813.4 (1240-4620)

Table II. Schirmer's Scores of the Right and Left Eyes in Preterm and Term Babies (*: significant)

		Term babies Mean ± SD (mm) (min–max)	Preterm babies Mean ± SD (mm) (min–max)	P value	Total Mean ± SD (mm)
Right eyes	Basal Schirmer's score	7.9±4.0 (0-18)	5.6±3.0 (1-11)	0.03*	6.7±3.7
	Reflex Schirmer's score	7.5±4.1 (0-18)	6.0±3.8 (0-15)	0.212	6.8±3.9
	Total Schirmer's score	15.4±6.6 (2-30)	11.6±5.5 (2-25)	0.04*	13.5±6.2
Left eyes	Basal Schirmer's score	8.9±4.3 (2-21)	5.2±2.8 (1-10)	0.01*	7.1±4.0
	Reflex Schirmer's score	8.0±4.6 (0-15)	5.9±4.2 (1-15)	0.106	6.9±4.4
	Total Schirmer's score	16.9±7.6 (4-35)	11.1±6.2 (3-25)	0.007*	14.0±7.4

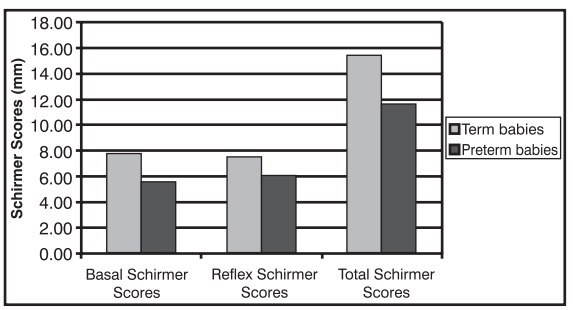

Fig. 2. Schirmer's test scores (mm) of the right eye, in term and preterm babies.

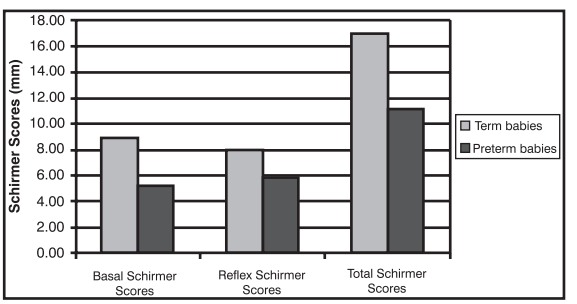

Fig. 3. Schirmer's test scores (mm) of the left eye, in term and preterm babies.

Table III. Grade of Ferning Patterns in Both Eyes in Term and Preterm Newborns

		Ferning patterns			
		Grade 1	Grade 2	Grade 3	Grade 4
Term babies	Right eye	12	8	1	0
	Left eye	10	10	1	0
Preterm babies	Right eye	6	13	1	0
	Left eye	4	14	2	0
Total		32	45	5	**0**

Moreover, there was no correlation between ferning capacity and post-conceptional age of the babies.

Mean total, basal and reflex Schirmer's results among babies with good and poor ferning capacities are presented in Table IV. Although the total and basal Schirmer's scores for eyes with good ferning patterns are higher than those for eyes with poor ferning patterns, no comparison could be performed due to the low number of subjects in the Rolando Grade 3 and 4 groups, since most babies demonstrated good ferning capacity. On the other hand, comparisons performed in groups with very good (Grade 1) and good (Grade 2) ferning patterns revealed that all the Schirmer's scores are significantly higher in the former group, indicating an improving effect of Schirmer's score on the ferning pattern ($p<0.005$).

Discussion

The tear ferning test is often used to assess the effects of drugs like N-acetylcysteine[7], topical retinoic acid[8], antioxidants[9] and hyaluronic

Table IV. Schirmer's Scores (mm) of the Right and Left Eyes with Good or Poor Ferning Capacity

	Eyes with good ferning capacity (right-left)	Eyes with poor ferning capacity (right-left)
Mean total Schirmer's score	14.2-15.0	9.3-8.0
Mean basal Schirmer's score	6.8-7.6	4.3-3.5
Mean reflex Schirmer's score	7.4-7.4	5.0-4.5

acid[10] on tear quality, as well as the efficacy of tear substitutes[11]. It has been used to assess tear quality in ocular surface diseases like pterygium[12] and during different phases of the menstrual cycle in healthy women[13]. Just like Schirmer's test, the ferning test is accepted as part of the diagnostic protocol in the evaluation of dry eye symptoms[14]. Hence, tear ferning capacity usually is considered a reflection of the quality of tears[7,8-14]. In this respect, we wanted to combine tear ferning capacity and Schirmer's tests in our evaluation of newborn tear properties, since prior studies using only Schirmer's test results have yielded conflicting results[3,5,15-17].

Diminished basal and reflex tear secretion among newborns may mask the symptoms of congenital nasolacrimal duct obstruction, and increase the local and systemic side effects of topical medications used in newborns. It is also necessary for newborns to have adequate basal and reflex tear secretion, in order to have good ocular antibacterial protection and maintain corneal clarity while being examined ophthalmoscopically. In spite of this, should newborn babies exhibit low Schirmer's test readings, they would be expected to present signs of insufficient ocular surface protection, which usually is not the case. This might imply that, in addition to tear quantity, tear quality is also an important feature that can be evaluated easily by means of ferning capacity testing, even in newborns.

Puderbach et al.[16], while investigating tear ferning, Schirmer's tests, break-up time and protein composition in subjects between 4 months and 85 years old, reported a positive correlation between tear ferning patterns and low Schirmer's test values, and between ferning patterns and tear break-up time. They stated that ferning pattern was not influenced by single tear proteins, but by the quantity of watery secretion[16]. They also stated that ferning patterns of higher degree were significantly more frequent with increasing age. We have also revealed that ferning capacity is correlated with higher Schirmer's test results but were unable to reveal a correlation between ferning pattern and the post-conceptional age of the babies. In our study, we additionally found that total, reflex and basal Schirmer's results are higher in newborns with very good ferning capacity (Grade 1) than in those with good ferning capacity (Grade 2). This correlation might become stronger, as Puderbach[16] has reported, with improved tear secretion and quality with advancing age.

The results of our study imply that tear ferning pattern and Schirmer's test results, albeit exhibiting two different properties of tears, are positively correlated in newborns in spite of the fact that tear ferning patterns deteriorate as temperature and humidity increase, a characteristic not shared by Schirmer's tests[18].

Spiegler et al.[5] evaluated tear secretion in newborns by means of the Schirmer-1 test. They reported that basal tear secretion was 5 mm ± 3 mm in 5 min. They stated that tear secretion was independent of the baby's age, birth weight, degree of maturity, and sex, findings that are partially supported by the results of our study. Our basal Schirmer's test results were 6.7 mm for the right eye and 7.1 mm for the left eye, both highly consistent with the results of Spiegler's[5] study. Apt and Cullen[3] established that full-term newborns produce tears normally, and that preterm infants also exhibit the capacity to secrete tears. They showed that 82% of non-crying full-term infants had normal tearing (defined as at least 15 mm of wetting of the tear test strip in 5 min) at 1 day of age, and that this percentage decreased to 14-63% for premature newborns, these results being correlated with body weight. This correlation between maturity and tear secretion level was also apparent in our study. Similarly, Patrick[15] reported that 84% of term infants display normal tearing; however, he was unable to determine any difference between term and premature newborns with respect to tear secretion.

Toker et al.[17] reported that mean total tear production was 16.3 mm in term and 7.4 mm in preterm infants. They also demonstrated that total, but not basal tear secretion, is correlated with birth weight and post-conceptional age. However, they were unable to detect any correlation between Schirmer's scores and birth weight or post-conceptional age.

The variability of Schirmer's test results can be attributed to increases in reflex secretion induced by eye blinking, which cannot be prevented in newborns, unlike in adults in whom the test can be employed with the patient's eyes closed. In addition, topical anesthesia is not absolute enough to test basal Schirmer's levels, because eyelid margins and cilia are still sensitive to irritation by the Schirmer's strip, which is relatively large for newborns. This raises disagreement with respect to basal and reflex tearing, because even using topical anesthesia, we still irritate eyelid margins and lashes and, hence, basal secretion cannot be measured without at least some degree of test interference. It also seems obvious that a normal test strip, which in adults can be positioned at the temporal margin of the lower eyelid so as not to irritate the cornea but in newborns will touch the cornea wherever it is placed because of its relative size, will cause more irritation and tearing in newborns than in adults. Consequently, we believe that Schirmer's tests are not accurate enough in newborns to evaluate tear properties and that additional tests, like measurement of tear ferning patterns, are warranted.

We hypothesized that any correlation between tear secretion and tear ferning pattern could be helpful in evaluating tearing capacity in newborns, because using the ferning test alone would be as accurate as Schirmer's test for the newborn, and our study confirmed a positive correlation between these two tests. In fact, we believe that they represent two different parameters of tear secretion (tear quality and tear quantity), which are affected by each other.

In conclusion, newborns secrete good quality tears in moderate quantity, and ferning patterns are affected by Schirmer's test scores. Tear secretion levels are correlated with post-conceptional age and birth weight. Given further that tear ferning can be assessed easily in newborns and that Schirmer's tests are already done in this population, perhaps both tear ferning capacity and Schirmer's tests could be utilized in the evaluation of newborns' tear properties.

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