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ORIGINAL ARTICLE

Evaluation of the effects of serum iron levels on lacrimal gland secretion

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Abstract In our study we aimed to demonstrate the relationship between the serum iron levels, and tears quality and quantity in term newborns. This study was conducted at a single institution between March 2013 and May 2013. A total of 46 newborns were prospectively enrolled. Serum iron levels were measured via the umbilical cord blood. Infants were divided into two groups according to their serum iron levels. Group A, serum iron level $\leq$70 μg/dL ($n = 27$) and Group B, serum iron level $>$ 70 μg/dL ($n = 19$). The evaluation of the osmolarity was tested by using the TearLab Osmolarity System (TearLab Co, San Diego, CA, USA). The assessment of quantity was performed by using Schirmer I test. Osmolarity testing and Schirmer I test (with/without anesthesia) were performed bilaterally on the 1st day of life by an ophthalmologist. The outcomes of Schirmer I and tear osmolarity showed no statistically significant difference between right and left eyes of any infant in the groups. Moreover, there was no statistical difference between sexes in these two groups. Osmolarity was found to have a moderate negative correlation coefficient with serum iron level ($r = -0.4$, $p < 0.01$). Furthermore, there was a high positive correlation between Schirmer I with anesthesia and serum iron levels ($r = 0.7$, $p < 0.01$). We observed that the quality and quantity of the tears was lower in term newborns with lower serum iron levels than healthy newborns. These results indicate that low serum iron level could affect lacrimal gland functions.

Conflicts of interest: All authors declare no conflicts of interest.

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Introduction

Nutritional deficiencies may affect epithelial organs such as the exocrine and endocrine glands, the mucosa, and the immune system. Low iron store has been shown to correlate with many diseases, and is an important cause of morbidity. It may also contribute to mucosal atrophy, candidiasis, oral soreness, and dry eye. Low iron store may also further impair lymphocyte functions which is a source of several immunological diseases [1].

Tear film assessment has two main parts: tear volume or quantity and tear stability or quality. The tear film coating the eye, known as the precorneal film, has three distinct layers. Those are lipid, aqueous, and mucous layers. The lipid and mucus layers are responsible for the quality of the tear film, while the aqueous layer provides the quantity of tears needed. The lacrimal glands secrete lacrimal fluid, which is composed of water, electrolytes, and other substances such as proteins. However, to date no evidence has been demonstrated about the effect of low iron store on lacrimal gland functions. Lozoff et al. [2] showed that infants with low iron store had a lower eye blink rate than healthy infants. In that study, they hypothesized that reduced dopamine function in iron-deficient anemic infants could play a role in spontaneous eye blink rate [2]. Lower eye blink rate may affect tear volume by increasing tear evaporation, and there might be a relationship between serum iron level and tear function. In addition, lacrimal glands secretion activity is also thought to be affected by a low iron store. From this standpoint, investigation of the association between the lacrimal gland functions and the degree of low iron store may help us to understand the critical role of iron on exocrine glands secretion activity.

Therefore, in this study we aimed to analyze the relationship between lacrimal gland functions and cord iron levels in neonates immediately after birth.

Methods

Institutional review board (Istanbul Medipol University) approval was obtained for the study protocol. A prospective study was conducted on the eyes of 46 medically stable, full-term newborn infants (38—41 weeks after conception), who were born at a single institution between March 2013 and May 2013. The tenets of the Declaration of Helsinki were followed and informed consent was obtained from the mother for each case. Babies with lid abnormalities, epiphora, conjunctival congestion, discharge, corneal disease, or glaucoma were excluded.

Tests were conducted in moderate room lighting and both eyes were tested consecutively. During sample collection, the infants were resting in a cot or were held by a parent. If an infant was alert, their eyelids were not kept open manually. The eyelids were allowed to close for blinking every 5 seconds to minimize the stress on the infant and to minimize reflex tearing. Three consecutive measurements for all tests were obtained, and their mean was analyzed. The TearLab osmolarity test (TearLab Co., San Diego, CA, USA) utilizes a temperature corrected impedance measurement to provide an indirect assessment of osmolarity (range from 275 mOsm/L to 400 mOsm/L). The equipment consists of single use test cards containing microchannels to collect tear fluid, held by a pen designed to facilitate tear collection, and a portable reader unit which elaborates and displays the osmolarity results. After testing osmolarity by using the TearLab equipment, excess moisture on the eyelid margin was dried by a sterile cotton applicator. Then, a sterile Schirmer tear test strip (Alcon Laboratories Inc., Fort Worth, TX, USA) was placed over the lower eyelid margin in the inferotemporal area without any contact between the cornea and the test strip. After 5 minutes, reflex plus basal secretion (Schirmer I test without anesthesia) scores were recorded in millimeters by measuring the wetting of the strips. To measure basal tear secretion (Schirmer I test with anesthesia), a drop of topical anesthetic agent proparacaine hydrochloride 0.5% was instilled in each eye. After waiting 2 minutes, a sterile Schirmer test strip was placed in the same place and 5 minutes later, wetting was measured and recorded in millimeters as basal secretion. Schirmer I with anesthesia was found to be more objective and reliable in terms of diagnosing dry eyes than without anesthesia [3]. Therefore, Schirmer I with anesthesia was preferred when performing correlation analysis with serum iron level.

Serum iron levels of newborn babies were derived from the umbilical cord blood samples by using the colorimetric method with Ferrimat-Kit (Bio-Mérieux, Marcy l'Etoile, France) and Photometer 4010 (Boehringer, Mannheim, Germany). Neonates were divided into two groups according to their serum iron levels: Group 1, serum iron level $\leq$70 μg/dL ($n = 27$) as the study group and Group 2, serum iron level $>$ 70 μg/dL ($n = 19$) as the control group [4].

Statistical analysis

The right eye of each neonate was selected for analysis. The normality of the distribution of each of the parameters was checked using the Kolmogorov-Smirnov normality test. The scores of Schirmer I test and tear osmolarity were statistically measured using correlation analysis, paired samples *t* test, and independent *t* test. Correlation analysis of Schirmer I test with anesthesia and tear osmolarity with serum iron level was performed by the Pearson linear correlation test. Correlation was described as weak, moderate, strong, and very strong when the correlation coefficient (r) was 0.000—0.250, 0.250—0.500, 0.500—0.750, and 0.750—1.000, respectively.

Results

The study included 46 full-term infants who met the inclusion criteria. There were 24 (52.1%) males and 22 (47.8%) females. The gestational age ranged between 38 weeks and 41 weeks (average 39.3 $\pm$ 1.3 weeks). The majority of the babies (32/46; 69.5%) were between 39 weeks of gestational age and 40 weeks of gestational age. The birth weight ranged between 2.45 kg and 4.5 kg (average 2.88 $\pm$ 0.69 kg). The presence of clinical findings, serum iron level $\leq$70 μg/dL, were taken as evidence of low iron store [4]. Twenty-seven infants were included in Group A, as the low iron store group, and 19 infants were included in Group B, as the control group. Characteristics of the