

The Evaluation of Red Reflex Sensitivity and Specificity Test among Neonates in Different Conditions

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Abstract

Objective: Red reflex test is an effective screening tool in the early diagnosis of neonatal eye abnormalities. The aim of this study was to detect the sensitivity and specificity of red reflex assessment in neonates, performed by pediatricians (or other care providers) in comparison with ophthalmologists. Also association between red reflex findings and neonatal variables is evaluated.

Methods: By a prospective study all neonates born from July 2011 until March 2012 in Mustafa Hospital, a general teaching hospital in Ilam city, Iran, were evaluated. Neonates were firstly investigated by pediatrician in substandard conditions at the first day of birth and several days later by ophthalmologist in standard conditions.

Findings: Totally 255 neonates including 141 boys and 114 girls were investigated, 144 of whom were born by cesarean section. There was a significant relationship between method of childbirth (72.9% disorders in CS vs 56.8% in vaginal delivery ($P<0.007$)), duration of delivery (disorders in prolonged: 100% and 11.8% vs no prolonged: 56.8% and 6.3% in standard and non standard conditions respectively ($P<0.0001$)), difficult delivery (98.6% disorders vs 6.5% in standard and non standard conditions respectively ($P<0.01$)) and increase or decrease of red reflex sensitivity test. A significant difference (identification of ophthalmic problems) was seen among neonates' inspections in primary hours and substandard conditions compared to further inspections in standard conditions particularly from 3rd day of birth.

Conclusion: Due to a considerable difference between the results of ophthalmic examination of neonates in different conditions, red reflex examination by pediatricians is suggested for all neonates to early identification of ophthalmic problems at the first step. It is also suggested a red reflex screening for all neonates before being discharged from hospital as well as 6 weeks later and in case of any problem to be referred to ophthalmologist.

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Key Words: Red Reflex; Neonates; Ophthalmic Disorders

Introduction

The red reflex test is an effective screening test in the early diagnosis of various illnesses and disorders of eyes, such as cataracts, glaucoma,

retinoblastoma, retinal disorders^[1,7]. The base of the red reflex test is that if the ophthalmoscope light directly placed on the optic axis of the dilated pupil, the pupil area would seem in a uniform light orange (close to red) color. The term "red reflex",

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is the reflection of the fundus color (the color combination of vascular area and choroid pigments), which returns to the front via the transparent eye path (vitreous, lens, aqueous, and the cornea). Any resentment placed within this path in the eye, partially or completely prevents the reflection, and would appear as a black mark or a shadow. Darkening the examination room normally allows the pupil to be dilated enough so that the central fundus could be examined. Dilating the pupil via drugs could greatly increase the sight, and enables a wider test in the sclera area^[2-4]. The Royal College of Pediatrics and the Royal College of ophthalmologists in England have suggested that the eyesight examination, with the red light reflex, must be a part of general examination for all neonates after birth, and also at the 6-8th week of life. Also, the American Academy of Pediatrics suggested that all neonates must be subjected to the eye's red reflex test by a pediatrician or a first aid doctor, over the first 2 months of life^[10-11]. There is no exact data in Iran to show the method of application and analysis of this test, or on genetic and ethnic-racial variations. The goal of this study was to analyze the sensitivity and specificity of the red reflex test among neonates and analyzing of the achieved results by pediatrician for detecting the eyesight problems and finally comparing it to the results achieved by ophthalmologist, few days after birth. This study also evaluated association between red reflex findings and neonatal variables.

Subjects and Methods

For conducting this prospective analytic study, all neonates born in the Martyr Mustafa Khomeini teaching referral hospital in Ilam, Iran between July 2011 until March 2012, were tested, hours after their birth by previously trained pediatricians in a non-standard condition (at the delivery room, beside mother and without the eyes being dilated), to detect the presence or absence of the red reflex via a indirect ophthalmoscope with zero lens (Riester ophthalmoscope, Made in USA), and after three days, were transferred to the ophthalmology clinic of Imam Khomeini referral teaching hospital,

in Ilam, and were examined by an ophthalmologist in standard conditions (a dark room with the dilated eyes). Eventually the findings reported by pediatric examination at the first few hours and in a non-standard condition were compared to the results obtained by ophthalmologic examination after few days and in a standard condition. Also the association between red reflex findings and neonatal variables was analyzed via Chi-square or t-test appropriately. The gold standard for estimation of sensitivity and specificity was ophthalmologic examination. Key variables in the study were red reflex examination by pediatrician vs ophthalmologist. Examiners recorded their findings as either presence or absence of red reflex.

The color gradient was intended to facilitate the registration and description of the characteristics of the reflex visualized in the test, making them the closest to the findings observed by the primary examiner and ophthalmologist, therefore in our study red reflex scorings were: bold red (10/10), Orange to reddish (5/10-10/10), orange (5/10), light yellow with fix dark spot (0/10-5/10) and milky white or asymmetry of reflexes (0/10). Only the measured scores of 10/10 at the first screening examination by pediatricians have been considered as normal.

Data were collected by prepared forms and using SPSS 16 both conditions were compared for differences and sensitivity rates. This study was approved by the Ethics Committee of Ilam University of Medical Sciences, under the number EC/92/H159 and informed consent was obtained from the parents of all neonates.

Findings

Totally 255 neonates including 141 (55.3%) boys and 114 (44.7%) girls were investigated of which 144 (56.5%) were born by cesarean section (CS). The mean age and standard deviation of participants was 28.20 ± 13.87 (5 to 79) hours (Table 1). Neonates with disturbed red reflex had a mean Apgar score 8.85 ± 1.38 , whereas those with normal red reflex showed an Apgar of 9.14 ± 0.213 . There was no statistical significant relationship between the red reflex results, and

Table 1: Demographic characteristics of participants in red reflex study in Ilam city

Variable	Value	
Age (hours)	Mean (SD): 28.2 (13.9) Range: 5-78	
Gender	Boys (%)	141 (55.3%)
	Girls (%)	114 (44.7%)
Method of birth	Vaginal (%)	111 (43.5%)
	Cesarean Section (%)	144 (56.5%)

SD: Standard deviation

mean Apgar score ($P=0.05$).

According to the results of this study, at the non-standard conditions, 34.1% of neonates had a $10/10$ red reflex, which increased to 90.6% in the standard conditions, and also the disturbed red reflex amount at the non-standard condition was 65.9%, which dropped to 9.4% under standard conditions (Table 2). Disturbed red reflex under non-standard conditions was reported in 168 cases, of whom in the final examination under standard conditions only 51 were diagnosed with ocular lesions. Also, of 87 cases reported as having normal red reflex, 9 neonates were identified to have ocular lesions. In examinations under standard conditions, 24 cases of abnormal red reflex were reported which was reduced to 11 cases at the final investigation and 231 cases of normal red reflex reported in the first observation reduced to 68 cases at the final examination (Table 2).

For the rate of ocular lesions under standard and non-standard conditions according to the red reflex test results see Table 3. Examination at the non-standard environment revealed that 72.9% of neonates born by CS, and 56.8% of those with vaginal delivery had a disturbed red reflex, with a statistically significant difference ($P=0.007$); however, these figures changed to 11.8% and 6.3% respectively during examination

under standard condition a few days later with statistically non significant difference ($P=0.1$).

Results indicated that, among neonates born by a prolonged delivery process, 100% of neonates examined at nonstandard condition and 19.2% of those at standard condition had a disturbed red reflex, but for those without a prolonged birth process, these figures accounted for 57.1% and 6.9% respectively. There was a significant relation between prolonged birth process and red reflex results in both standard and non-standard examinations ($P<0.0001$).

Among those with a history of difficult labor, 98.6% and 6.5% of neonates examined at non-standard and standard conditions respectively had a disturbed red reflex, indicating a significant relation between difficult labor and the red reflex disturbances in both examination methods ($P<0.01$).

The results of sensitivity and specificity of red reflex examination under non-standard condition is shown in Table 4. There was a significant relationship between method of delivery, duration of delivery, complicated delivery and intensity of red reflex sensitivity. A significant difference in results (identification of ophthalmic problems) was seen in neonates' inspection in the first hours under substandard conditions compared to further inspections in standard conditions

Table 2: Red reflex test results under non-standard condition by pediatrician and standard condition by ophthalmologist among participants in red reflex study in Ilam city

Examination result		First report n (%)	Final report n (%)
Non-standard (n=255)	Abnormal	168 (65.9%)	51 (20%)
	Normal	87 (34.1%)	9 (3.5%)
Standard (n=255)	Abnormal	24 (9.4%)	11 (4.3%)
	Normal	231 (90.6%)	68 (26.7%)

P. value: 0.0001

Table 3: Distribution of red reflex test results under non-standard and standard conditions in participants in red reflex study in Ilam city

Examination conditions	Lesion type	Red reflex test [Frequency (%)]			P. value
		Normal	Abnormal	Total	
Non-standard	Without lesion	78 (40)	117 (60)	195	0.0001
	Retinal hemorrhage	3 (6.8)	41 (93.2)	44	
	Vessel reduction	5 (50)	5 (50)	10	
	Salt-and-pepper Retinopathy	0	5 (100)	5	
	Retinal color change	1 (100)	0	1	
Standard	Without lesion	163 (92.6)	13 (7.4)	176	0.0001
	Retinal hemorrhage	51 (87.9)	7 (12.1)	58	
	Vessels reduction	8 (80)	2 (20)	10	
	Salt-and-pepper Retinopathy	6 (100)	0	6	
	Retinal color change	3 (60)	2 (40)	5	

particularly from 3rd day of life.

Discussion

A significant variety of red reflex could be present among children from different races or nations because of the various levels of ocular fundus pigmentation. This is a very sensitive test and the examiner must pay an absolute attention to prevent any false positive or false negative results, because there are no specific national instructions on this matter^[2,5,7].

The results of our study indicated that there was a significant difference between the examinations by pediatrician, and the results obtained by an ophthalmologist and there was no significant relation between age, weight or Apgar score and red reflex under standard or non-standard conditions.

A study by de Aguiar and colleagues specified that 187 out of 190 neonates born in a general hospital had no changes or variations, while 3 cases were suspicious. This study also reported, 50 (26.3%) cases were red, 34 (17.9%) orange to

reddish, 92 (48.8%) orange, 11 (5.8%) light yellow and 3 (1.6%) cases were milky white and indicated a significant statistical relation between the color gradient and neonatal variables, such as: weight ($P=0.03$), gestational age ($P=0.02$), and oxygen therapy ($P=0.02$)^[8].

The results of current study in the standard conditions revealed that 11 out of 24 cases reported for disturbed red reflex had ocular lesions in the final examination and among 231 cases reported as normal red reflex 68 individuals had ocular lesions, in accordance with the study performed in Brazil by Rodrigues and colleagues. They clarified that during one year study; only 16 out of 29 children reported with red reflex disorders were confirmed^[11].

There was no significant relationship between retinal hemorrhage and type of birth, prolonged birth process or dystocia during neonatal examination under non-standard conditions; however, a significant relationship was revealed between the above mentioned factors during their examination under standard conditions.

In our study, 31% of the neonates had ocular lesions, which included 22.7% retinal hemorrhage, 3.9% reduced vessels, 2.4% salt paper and 2% retinal discoloration, which indicated a higher

Table 4: Sensitivity and specificity of red reflex examination at non-standard condition

Statistic	Abnormal	Normal	Total	Sensitivity	Specificity
Test positive	51	117	168	85%	38.5%
Test negative	9	78	87		
Total	60	195	255		

prevalence of retinal hemorrhage among neonates at the early birth postpartum examinations. This was lower than the results achieved by Li and colleagues with a prevalence of 21.5% for retinal hemorrhage among 3573 examined neonates^[11].

In a study inducted by Sotomi and colleagues in 2007, it was shown that among 27 neonates detected with congenital and infantile cataracts 17 infants (63%) were diagnosed with bilateral disease, while the remainder were unilateral 10 (37%). Most of the cases 17 (63%) were diagnosed following presentation with parental/career concerns about visual function (usually a squint). However only 2 of these 17 cases were presented before 3 months of life. The remaining cases of congenital cataracts were diagnosed by general practitioners 8 (24%), pediatricians 4 (12%), ophthalmologists 3 (9%) or School Medical Officer (1, 3%). No case of congenital cataract was diagnosed by newborn screening examination. None of the neonates with congenital or infantile cataract were detected by Newborn Screening Tests^[10].

Eventov-Friedman and colleagues during a study performed the red reflex test to examine the neonates and reported 5 neonates with cataract were detected within days 4-5 of their life and suggested that the red reflex examination must be placed as a part of neonatal examinations^[1].

In our study there was a significant difference between the examinations under non-standard conditions by pediatrician, and the results obtained under standard conditions by an ophthalmologist ($P < 0.0001$). It may be related to this fact that pediatricians do not have enough experience or it may be due to ocular and tear film problems in the first day of life that gave rise to disturbance of red reflex and disappeared within few days especially in babies with difficult deliveries or low Apgar scores. Based on the incidence of corneal edema and its severe effects on the red reflex over the first hours of life, early application of the red reflex examination under standard condition (dark room and dilated pupil) is highly important. Also by time passing and increasing age of neonates, the corneal edema is gradually reduced and better conditions are prepared for ophthalmologic examinations that can result in increasing test accuracy and higher sensitivity in detecting neonatal eye defects.

Conclusion

Applying a red reflex test in the first hours of life by a pediatrician in all neonates is important, and therefore it is recommended as an early diagnostic tool in detecting neonatal eye defects. This can reduce the delayed referrals to the ophthalmologist. In case of any abnormality in the red reflex test further examinations under standard conditions by ophthalmologist is necessary. Performing this test with a standard method (dark room and dilated pupil), could lead to improving the diagnostic screening results compared to that under non-standard conditions. Of course, potential threats of using the cycloplegic drugs in neonates and infants must be mentioned. It is suggested to examine all neonates with red reflex test before being discharged from hospital and 6 weeks after birth under standard conditions. The pediatricians should be trained and educated enough to lower this difference with specialists and increase the accuracy of red reflex assessment.

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Authors' Contribution

M. Mussavi: Designed the first concept and prepared data and helped in the first draft of manuscript.
 K. Asadollahi: Analyzed and interpreted the data, participated in the manuscript preparation and critical revision.
 F. Janbaz: Participated in the manuscript preparation and critical revision.
 E. Mansorri: prepared data and helped in the first draft of manuscript.
 N. Abbasi: Participated in the manuscript preparation and critical revision.
 All authors read and approved the final version of article.

Conflict of Interest: None

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