



Comparison of Red Reflex Determination and Indirect Ophthalmoscopy in New Born Admitted to Neonatal ICU. A Validation Study

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Abstract: Background: Since there is currently a dearth of local literature in this area, the goal of this study was to gather local data in order to create our own technique for determining red reflex based on evidence-based research. If low sensitivity is also discovered, we can request that the health department switch the red reflex screening test to indirect ophthalmoscopy. This would allow the condition to be detected early and treated promptly, hence lowering morbidity. **Methods:** A cross sectional validation study was carried out at the department of Paediatrics, Khyber teaching hospital, Peshawar, during the period January 2025 till July 2025, over 140 male and female participants aging 1 to 28 days. Red reflex was elicited to diagnose cataract and diagnostic accuracy was compared taking indirect ophthalmoscopy as gold standard. **Results:** The mean age of the participants was 7.59 ± 2.595 days and 72 patients (51.4%) were aging more than 7 days and 84 participants (60.0%) were male. Taking indirect ophthalmoscopy as gold standard, the sensitivity, specificity, positive predictive value, negative predictive value and accuracy of red reflex for cataract was 80.0%, 57.5%, 58.5%, 79.3% and 67.1% respectively. **Conclusion:** Red reflex test is a simple, convenient, cost effective and technically less demanding tool to diagnose cataract in newborn with reasonable diagnostic accuracy. The test is should be implemented in resource limited settings like ours in neonatal assessment.

Keywords: Neonatal Cataract, Red Reflex, Indirect Ophthalmoscopy, Diagnostic Accuracy

INTRODUCTION

According to statistics by the World Health Organization (WHO), slightly less than 1.5 million kids are entirely blind, and another 20 million have some degree of visual impairment. There haven't been many epidemiological investigations on childhood blindness. According to some research, there are currently 0.8 out of every 1000 children that are blind.

[1] Prompt implementation of precautionary measures, evaluation, and management might have prevented at least a quarter of these episodes. [2] A joint statement by various societies issued a policy stating that "Red reflex testing is a vital component of the newborn, infant, and child physical examination." [3] In red reflex, the pupil appears red when light is

reflected off the back part of the eyeball when observed under ophthalmoscope. Any obstruction that prevents light from getting past the eye shall be seen as a dimmer red reflex; if the red reflex completely ceases to function, the pupil will seem gloomy. [4]

Numerous facets associated with the red reflex test have undergone thoroughly examined throughout the course of time, and physicians and other health care providers now advise using the procedure as a low-cost method for quick advantageous examination of newborns for frequently encountered sight-threatening conditions and other mimicking disorders of leukocoria. [5] In developing countries, approximately 44–62% of the kids who have pediatric cataract treatment achieve a postoperatively eye sight of 6/18 or greater; this is mostly due to delayed presentations. On the other hand, 72–91% of patients in countries with a high income attain much better postoperative outcomes. Additionally, there is a significant disparity in retinoblastoma complications and deaths among developing and industrialized nations, with a seventy percent death rate in less developed nations and less than 3% in high-income areas. [6]

The red reflex test, which uses an indirect ophthalmoscope, can identify both infantile cataract and retinoblastoma. Existing WHO guidelines for identifying juvenile visual illness solely recommend sight screening and torchlight inspection in basic vision treatment centers; they lack recommendations for red reflex screenings. [6] However, earlier research revealed that the level of sensitivity was modest. In a Spanish investigation, the red reflex's specificity was 89.5% while its sensitivity was just 56.4%. 70.4% was the positive predictive value, while 82.2% was the negative predictive value. [7]

This study aimed to determine diagnostic accuracy of red reflex in diagnosis of cataract in neonates keeping indirect ophthalmoscopy gold standard. Since there is currently a dearth of local literature in this area, the goal of this study was to gather local data in order to create our own technique for determining red reflex based on evidence-based research. If low sensitivity is also discovered, we can request that the health department switch the red reflex screening test to indirect ophthalmoscopy. This would allow the condition to be detected early and treated promptly, hence lowering morbidity.

METHODS

A cross sectional validation study was carried out at the department of Paediatrics, Khyber Teaching Hospital, Peshawar, during the period January 2025 till July 2025, over 140 male and female participants aging 1 to 28 days and evaluated for the presence of cataract with red reflex. Newborn with retinopathy of

prematurity, poly-congenital deformities and history of traumatic injury were excluded. Red reflex was elicited in a dark room by throwing light from a torch into eyes of the child. Appearance of reddish glow in the eyes was called normal and absence of reddish glow was considered suggestive of cataract. The red reflex findings were compared with indirect ophthalmoscopy which was considered gold standard. Presence yellowish or whitish opacities in the lens were considered confirmatory for cataract. Diagnostic accuracy of red reflex taking indirect ophthalmoscopy was gold standard was recorded in terms of sensitivity (patients correctly identified as cataract by red reflex), specificity (patients correctly identified by red reflex without cataract), positive predictive value (likelihood of having cataract on red reflex and confirmed with indirect ophthalmoscopy) and negative predictive value (likelihood of not having cataract on red reflex and confirmed with indirect ophthalmoscopy). Sample size was 140, calculated using taking anticipated prevalence of congenital cataract as 35% [8], 56.4% sensitivity, 89.5% specificity, [7], 10% absolute precision and 95% confidence level.

A written informed consent was taken from parents taken after explaining the purpose of study. Demographic data regarding age, gender, gestational age and birth weight was noted. All neonates were screened with the red reflex. Immediately afterwards, they were pharmacologically dilated and indirect ophthalmoscopy was performed. All of the red-reflex screening and the funduscopy examination were performed by the same evaluator. Findings of both examinations were noted and entered in performa. Data was entered and analyzed by using SPSS version 22.0. Mean $\pm$ standard deviation was calculated for quantitative variables like age, gestational age and birth weight. Frequency and percentage was calculated for categorical variables like gender. Sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy was calculated for red reflex using indirect ophthalmoscopy as gold standard by constructing 2x2 table. Effect modifiers like age, gender, gestational age and birth weight were addressed through stratification of data. Post stratification diagnostic accuracy was calculated using standard formulas:

Accuracy: $\frac{\text{True Positive Cases} + \text{True Negative Cases}}{\text{Total number of patients in the study}}$

Sensitivity: $\frac{\text{True Positive}}{\text{True Positive} + \text{False Negative}}$

Specificity: $\frac{\text{True Negative}}{\text{True negative} + \text{False Positive}}$

Positive Predictive Value: $\frac{\text{True Positive}}{\text{True Positive} + \text{False Positive}}$

Negative Predictive Value: $\frac{\text{True Negative}}{\text{True Negative} + \text{False Negative}}$

Total number of patients in the study

RESULTS

The mean age of the participants was 7.59 ± 2.595 days and mean weight was 2333.286 ± 269.276 grams. 72 patients (51.4%) were aging more than 7 days and 84 participants (60.0%) were male. 88 patients (62.9%) were born at gestational age 37 weeks or above while 75 (53.6%) patients belonged to urban areas as shown in table 1.

Table 1. Baseline characteristics of study participants (n = 140)

Parameters	Subgroups	Frequency	Percent
Age (days)	7 or below	68	48.6
	More than 7	72	51.4
Gender	Male	84	60.0
	Female	56	40.0
Weight (kg)	2300 or below	50	35.7
	More than 2300	90	64.3
Gestational age (weeks)	37 and above	88	62.9
	Below 37	52	37.1
Residence	Rural	65	46.4
	Urban	75	53.6
Mother education	No formal schooling	43	30.7
	Matric or below	60	42.9
	Above matric	37	26.4
SE status	Poor	55	39.3
	Fair	85	60.7

Red reflex was positive in 82 patients (58.6%) while indirect ophthalmoscopy was positive in 60 participants (42.9%) as reported in table 2.

Table 2. Red reflex and indirect ophthalmoscopy among study participants (n = 140)

Modality		Frequency	Percent
Red reflex	Positive	82	58.6
	Negative	58	41.4
Indirect ophthalmoscopy	Positive	60	42.9
	Negative	80	57.1

Taking indirect ophthalmoscopy as gold standard, the sensitivity, specificity, positive predictive value, negative predictive value and accuracy of red reflex for cataract was 80.0%, 57.5%, 58.5%, 79.3% and 67.1% respectively as reported in table 3.

Table 3. 2x2 analysis and diagnostic accuracy of red reflex taking indirect ophthalmoscopy as gold standard (n = 140)

		Indirect Ophthalmoscopy		Total	P value	Diagnostic accuracy
		Positive	Negative			
Red reflex	Positive	48	34	82	0.000	Sen=80.0% Spe=57.5% PPV=58.5% NPV=79.3% Acc=67.1%
		58.5%	41.5%	100.0%		
	Negative	12	46	58		
		20.7%	79.3%	100.0%		
Total		60	80	140		
		42.9%	57.1%	100.0%		

DISCUSSION

In this study, mean age of the participants was 7.59 ± 2.595 days and 72 patients (51.4%) were aging more than 7 days and 84 participants (60.0%) were male. Taking indirect ophthalmoscopy as gold standard, the sensitivity, specificity, positive predictive value, negative predictive value and accuracy of red reflex for cataract was 80.0%, 57.5%, 58.5%, 79.3% and 67.1% respectively.

Since visual disorders may continue until adult and may trigger irreparable visual impairment if they are

not identified and addressed, prompt testing and timely therapy of visual anomalies ought to commence from childbirth. Given the current state of understanding on pediatric visual illnesses and the benefits associated with prompt treatment, it is necessary to test kids for ocular anomalies far earlier than was previously advised.[9] Researchers are currently given the option of using quick and easy techniques for screening or more complicated but reliable approaches thanks to advancements in screening processes. The evaluation was only

necessary at childbirth and once further at age four under the previous eye checkup plan. However, new research findings have expanded the prior screening regimen to include a comprehensive eye examination at six months of age.[10]

Red reflex is a test in wherein both eyes are concurrently viewed utilizing an ophthalmoscope, was proven to be an efficient way to check for visual impairment, bilateral sharpness, and eye conditions in babies by Anne RP et al.[11] In Umbria, 22,884 live births were recorded throughout the research period, and 22,272 of those newborns underwent RER, according to a study by Mndeme FG, et al.[6] During the course of the three-year study, the RER Test was performed on 97.3% children in Italy. Of these, 461 newborns (4.83%) had uncertain or positive test outcomes and were subsequently sent to specialized center, in which three newborns were discovered to have a significant eye abnormalities (two with retinoblastoma and one with congenital cataract). The research found that the red reflex test ought to be an integral component of regular newborn evaluation since it is inexpensive and easy to administer, and that the substantial amount of incorrectly identified instances linked with this test's use is outweighed by its benefits.[12]

Additionally, since no cases of genetic visual anomalies were identified during subsequent examinations, it was established that the test was extremely effective. In the research conducted by Mussavi M et al. [13] discovered that newborns delivered after a protracted or challenging delivery had a greater rate of aberrant red reflex reaction. According to Sun M et al. [14], the test is more successful in screening for visual disturbances in front section eye conditions than in the posterior segment. Singh KA, et al. [15] conducted another research with the goal of screening newborns for eye conditions and gathering information on the prevalence of eye disease in this population. 15,398 neonates participated throughout the testing scheme, which comprised the red reflex test, outer eye inspection, and response to light excitation. Of these, 1266 instances encompassing a dozen distinct eye illnesses were found (case prevalence rate: 8.22%). Seven of the twelve eye conditions had a hereditary background, accounting for 809 of all cases and having a 5.254% prevalence elaborating the importance of red reflex testing. Similar findings were reported in another study.[16]

CONCLUSION

Red reflex test can help diagnose and rule out cataract in newborns with ocular anomalies. We suggest RRT as sensitive test for the identification of anterior segment anomalies based on the evidence at present. It was discovered that the specificity of RRT was comparable and unaffected by anterior or posterior segment defects. However, a cautious assessment of

the data is necessary due to the nonuniformity of the RRT participants.

BIBLIOGRAPHY

1. Taksande A, Jameel PZ, Taksande B, Meshram R. Red reflex test screening for neonates: A systematic review and meta-analysis. *Indian J Ophthalmol*. 2021;69(8):1994-2003.
2. Haefeli LM, Neves LM, Zin A, Costa ACC, Vasconcelos Z, Pinto M. Portable wide-field digital imaging for screening of neonatal visual impairment causes in Rio de Janeiro, Brazil: a budget impact analysis. *BMJ Open*. 2022;12(6):e056498.
3. American Academy of Pediatrics; Section on Ophthalmology; American Association for Pediatric Ophthalmology And Strabismus; American Academy of Ophthalmology; American Association of Certified Orthoptists. Red reflex examination in neonates, infants, and children. *Pediatrics*. 2008;122(6):1401-4.
4. Subhi Y, Schmidt DC, Al-Bakri M, Bach-Holm D, Kessel L. Diagnostic Test Accuracy of the Red Reflex Test for Ocular Pathology in Infants: A Meta-analysis. *JAMA Ophthalmol*. 2021;139(1):33-40.
5. Honavar SG. The Red Reflex Test - Shadow conceals, light reveals. *Indian J Ophthalmol*. 2021;69(8):1979-81.
6. Mndeme FG, Mmbaga BT, Kim MJ, Sinke L, Allen L, Mgaya E, et al. Red reflex examination in reproductive and child health clinics for early detection of paediatric cataract and ocular media disorders: cross-sectional diagnostic accuracy and feasibility studies from Kilimanjaro, Tanzania. *Eye (Lond)*. 2021;35(5):1347-53.
7. Viquez MV, Wu L. Sensitivity and specificity of the red reflex in Costa Rican newborns. *Arch Soc Esp Oftalmol*. 2020;95(1):4-8.
8. Kalua K, Patel D, Muhit M, Courtright P. Causes of blindness among children identified through village key informants in Malawi. *Can J Ophthalmol*. 2008;43(4):425-7.
9. Subhi Y, Schmidt DC, Al-Bakri M, Bach-Holm D, Kessel L. Diagnostic test accuracy of the red reflex test for ocular pathology in infants: a meta-analysis. *JAMA ophthalmology*. 2021 Jan 1;139(1):33-40.
10. da Cunha LP, Cavalcante Costa MA, de Miranda HA, Reis Guimaraes J, Aihara T, Ludwig CA, Rosenblatt T, Callaway NF, Pasricha M, Al-Moujahed A, Vail D. Comparison between wide-field digital imaging system and the red reflex test for universal newborn eye screening in Brazil. *Acta Ophthalmologica*. 2021 Nov;99(7):e1198-205.
11. Anne RP, Rahiman EA, Bharti LK. Newborn Screening: A Practical Guide to Pediatricians and Neonatologists. *Journal of Neonatology*. 2024

- Jun;38(2):309-18.
12. Duret A, Humphries R, Ramanujam S, te Water Naudé A, Reid C, Allen LE. The infrared reflex: a potential new method for congenital cataract screening. *Eye*. 2019 Dec;33(12):1865-70.
 13. Mussavi M, Asadollahi K, Janbaz F, Mansoori E, Abbasi N. The evaluation of red reflex sensitivity and specificity test among neonates in different conditions. *Iranian Journal of Pediatrics*. 2014 Nov 7;24(6):697.
 14. Sun M, Ma A, Li F, Cheng K, Zhang M, Yang H, Nie W, Zhao B. Sensitivity and specificity of red reflex test in newborn eye screening. *The Journal of pediatrics*. 2016 Dec 1;179:192-6.
 15. Singh KA, Taksande A. Diagnostic Accuracy of Red Reflex Test (RRT) for Early Detection of Ocular Abnormalities in Newborn. *Journal of Pharmaceutical Research International*. 2021;33(32B):185-91.
 16. Toli A, Perente A, Labiris G. Evaluation of the red reflex: An overview for the pediatrician. *World journal of methodology*. 2021 Sep 20;11(5):263.